

NOTES ON THE LIFE HISTORY AND ECOLOGY OF THE DRAGONFLIES (ODONATA) OF WASHINGTON AND OREGON.

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My interest in western Odonata started with the collecting I did in eastern Oregon in 1898 for Mr. E. B. Williamson, who has ever since encouraged me in further work along the same line. Since 1901 I have had further encouragement through correspondence with Dr. E. M. Walker, who has very kindly assisted me in the determination of Aeshnid material and in the determination of various nymphs. Without such help, work on western insects would be very difficult, because of the inaccessibility of much of the literature. That which is available is purely systematic and written by men who have only in rare cases seen the living insects in the field, because of which I have in this paper made live color notes and ecological data very full. This is the first of three general papers on western Odonata. The second is in preparation, and covers collecting done in California and Nevada during 1914. The summer of 1915 I hope to spend collecting in the southwestern States, and to publish the results in the third paper. A list of western Odonata is in preparation, but will not be completed until after this third summer's work is finished.

1. NOTES ON ARCHILESTES CALIFORNICA.

Only two species are known in the genus *Archilestes*. *Archilestes grandis* is a species long known from Mexico, Central America, and the Southwestern United States, having been first described by Rambur as *Lestes grandis* in the year 1842. In 1862 Selys raised the single species to generic rank as *Archilestes grandis*. In 1895¹ McLachlan described a new species, which he named *californica*. It was based on a single male specimen, presumably obtained in "California." The second species was based on differences in coloration, the main points of which were, that *californica* lacked a metallic coloration and had the costa and median veins yellowish. In 1901 Calvert²

¹ McLachlan, R. Some new species of Odonata of the "Legion" Lestes. Ann. Nat. Hist., ser. 6, vol. 16, p. 20, 1895.

² Calvert, Philip P., Biologia Centrali-Americana, Odonata, p. 46, October, 1901.

listed as *grandis* a single male specimen collected at Yakima, Washington.

During the past season (1913) I found *Archilestes* abundant on Satus Creek, Washington, from August 1 until October frosts killed the brood at the height of its numbers. A few specimens were taken in my dooryard 2 miles north of Sunnyside, Washington, which had emerged from nymphs brought down from the Yakima River in the Sunnyside irrigation canal, on whose bank my home stood. Probably because of the widely scattered points at which *Archilestes* has been taken in the Yakima Valley, it is found throughout the lower stretches of the Yakima River and its tributaries. However, as no record exists of specimens having been taken north of California, this is probably an isolated brood, perhaps the northern outpost of the genus.

As there are certain differences between the specimens of the brood from Satus Creek, Washington, and specimens of *grandis* from Mexico which I have examined, and as these correspond fairly well with McLachlan's description of *californica*, I have used the name *californica*. At first I thought their isolation had given them perhaps the characters of a local race and so inclined to classify them as *grandis*, but on collecting in the Sacramento Valley and after studying the specimens of *Archilestes* in the Stanford collection, which have been taken around Palo Alto, I am inclined to think that *californica* is a good species, as all the California material is identical with the Yakima Valley specimens. The main differences are that the specimens of *californica* are smaller, lighter colored, and have less metallic coloration than the true *grandis* forms. McLachlan states that the costa and median veins in the *californica* type are yellow. In some of my Yakima material, which is old and pruinose, the subcostal vein is light brown, though none have any of the veins distinctly yellow.

The following is a brief description of specimens from Satus Creek, Washington:

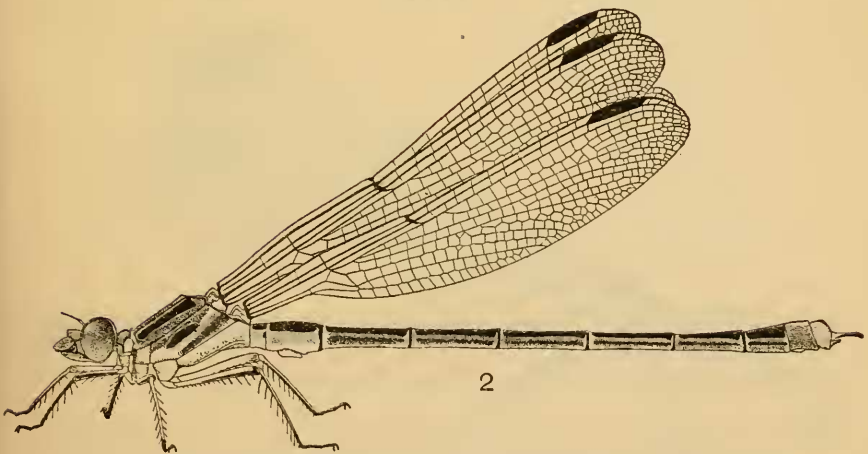
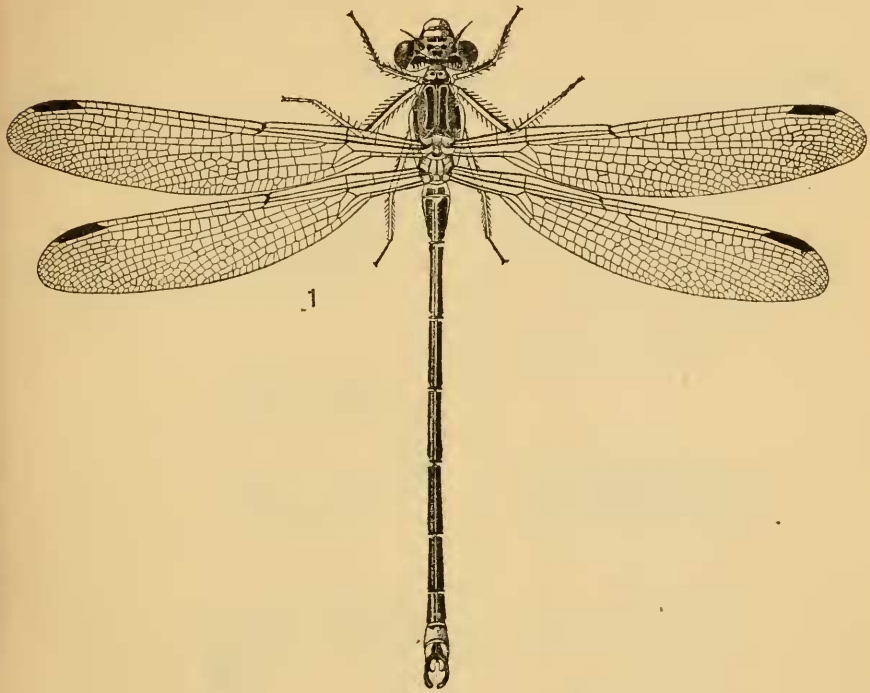
ARCHILESTES CALIFORNICA McLachlan.

Figs. 1-26.

Male (figs. 1 and 2).—Labrum in teneral specimens pale brown, becoming greenish in the older males; frons pale brown on vertical surface, and brown with a black transverse line on the horizontal surface. Vertex brown, with a complex pattern in black. In the older specimens the dorsal surfaces of the head become black, with the brown areas reduced to fine pencilings. Antennae black, except a brown ring around apex of second segment. Eyes in mature males blue in the upper half, shading into gray below.

Prothorax pale brown in teneral specimens, with a transverse row of four black spots. In older specimens the general color becomes

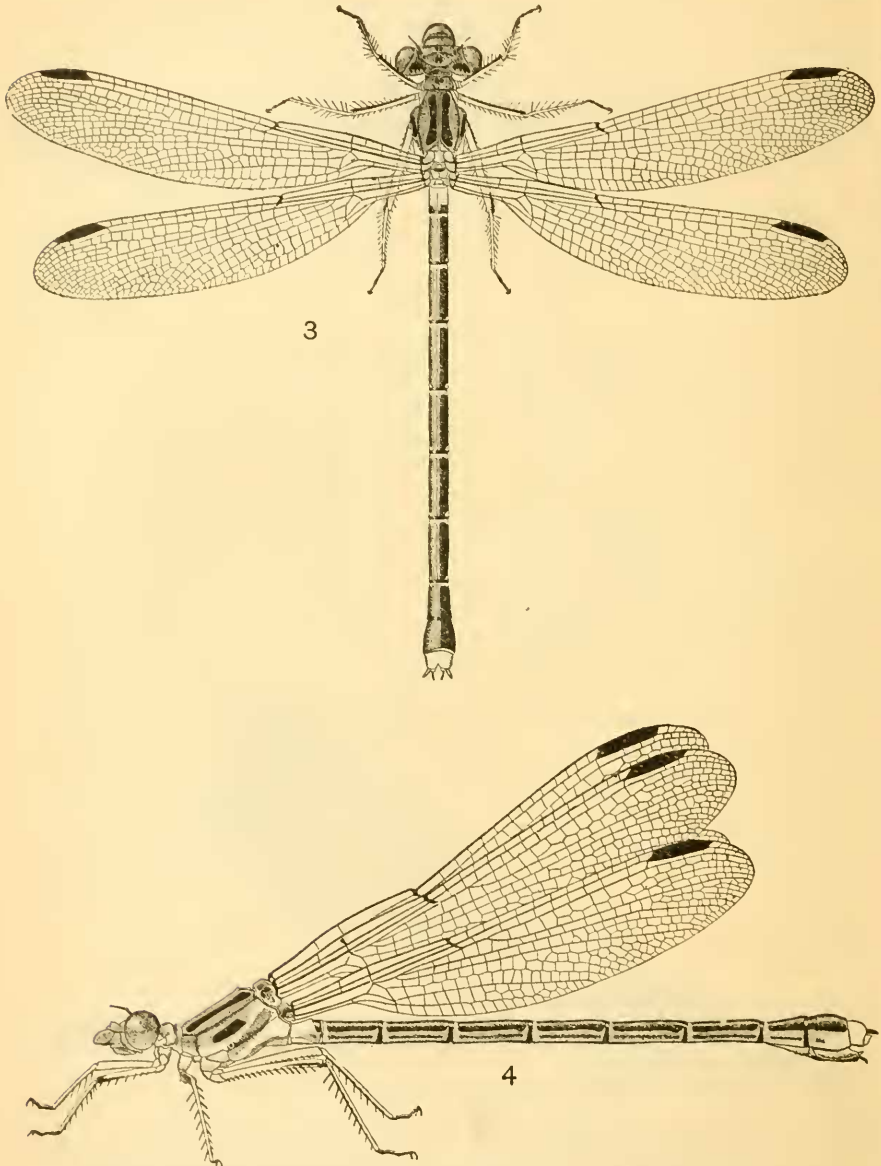
darker, the posterior lobe becomes black, and the sides become pruinose. Legs brown, with a black stripe on the anterior and another on the interior faces of femur and tibia. Tarsi black.



FIGS. 1-2.—ARCHILESTES CALIFORNICA, MALE. 1. DORSAL VIEW. 2. LATERAL VIEW.

Mesothorax and metathorax in teneral specimens brown, darker above. Each mesepisternum with a black stripe entirely surrounded by a narrow light-brown line. This black stripe usually

occupies from one-third to one-half the width of the mesepisternum, widens upward, and its inner upper angle touches the antealar sinus. Each mesepimeron with an elliptical or sometimes quadrangular

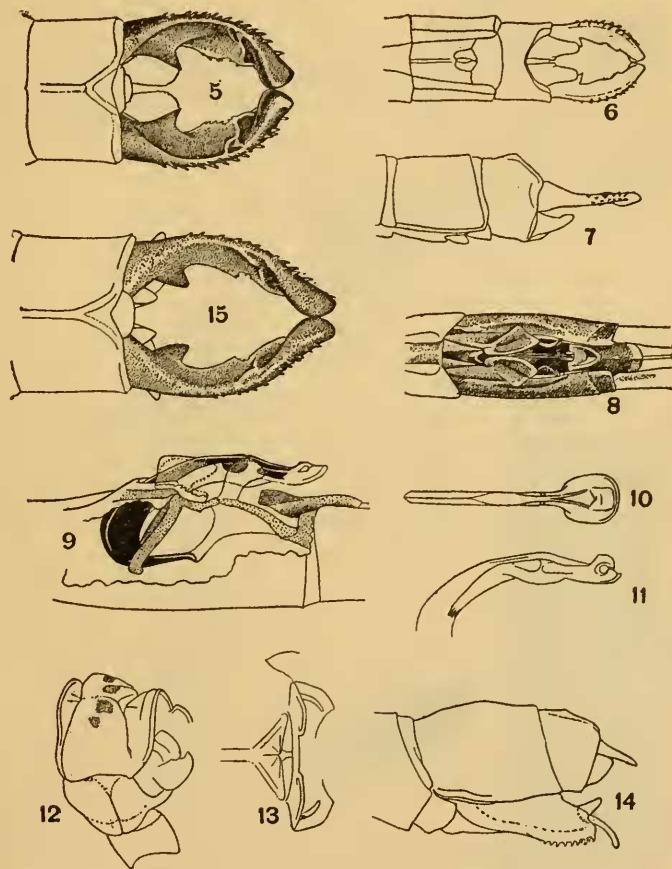


FIGS. 3-4.—*ARCHILESTES CALIFORNICA*, FEMALE. 3. DORSAL VIEW. 4. LATERAL VIEW.

black spot extending over the two middle fourths of its length. Just posterior to this, but on the metepisternum, a creamy stripe, which becomes white pruinose in the mature males. This is followed

by a stripe anterior to the second lateral suture, which is brown and does not become pruinose. The metepimeron is brown in the teneral, with creamy areas, but becomes white pruinose in the adult. Legs colored as in the prothorax. Wings hyaline, with brown stigmas.

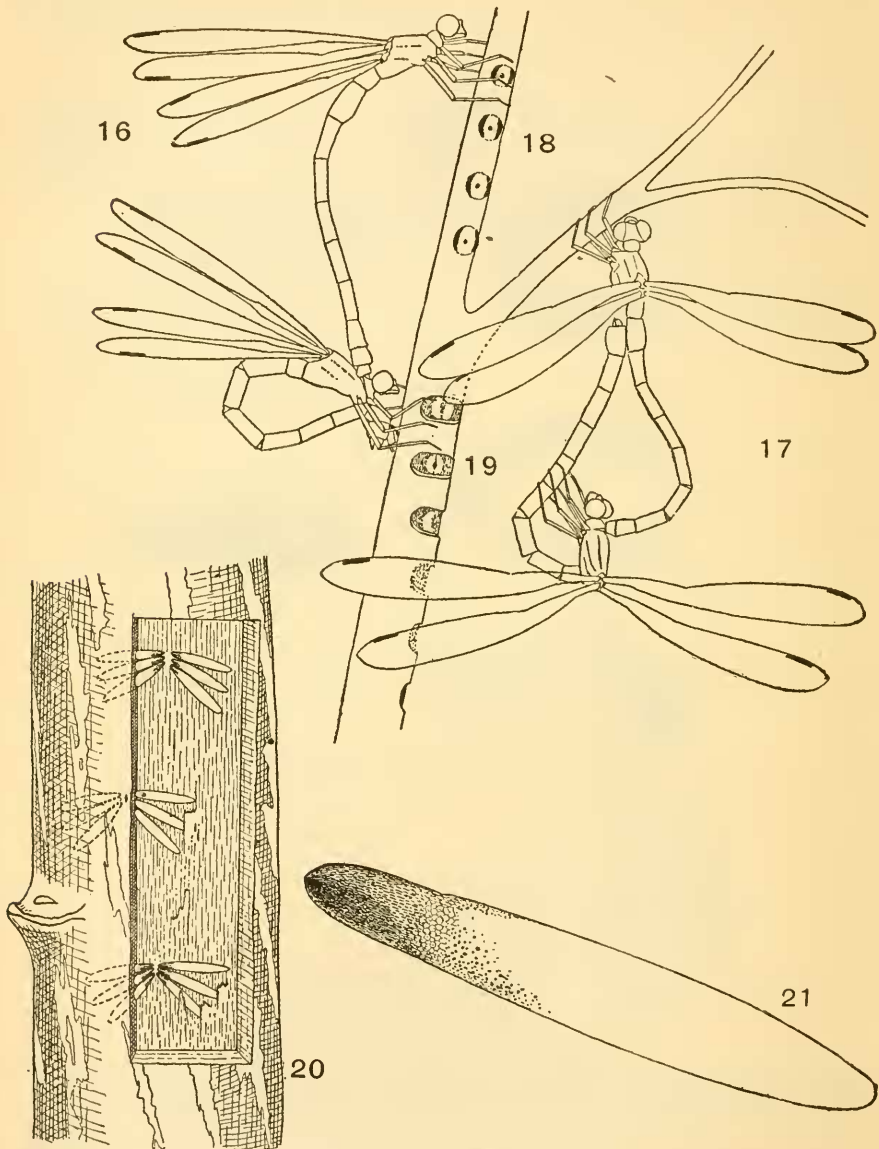
Abdomen in teneral specimens pale brown, with the following markings: All segments with a narrow apical black ring; segment 1



FIGS. 5-14.—*ARCHILESTES CALIFORNICA*, YAKIMA MATERIAL. 5-7. MALE APPENDAGES. 8. MALE SEGMENT 2, VENTRAL VIEW. 9. MALE SEGMENT 2 SHOWING CHITINOUS FRAMEWORK. 10-11. PENIS. 12. FEMALE PROTHORAX. 13. FEMALE MESOSTIGMAL LAMINA. 14. FEMALE ABDOMINAL SEGMENTS 9 AND 10. 15. *ARCHILESTES GRANDIS*, GUATEMALA MATERIAL, DORSAL VIEW OF MALE APPENDAGES.

with a black spot on each side of dorsal surface; segments 2-8 black on dorsal surface, with a narrow interrupted basal band and a fine middorsal line; segments 9-10 pale brown. Superior appendages with distal two-thirds black. The dorsal black areas of the abdomen show slight greenish metallic reflections. In the mature males the brown areas of the abdomen become darker and the black areas lose

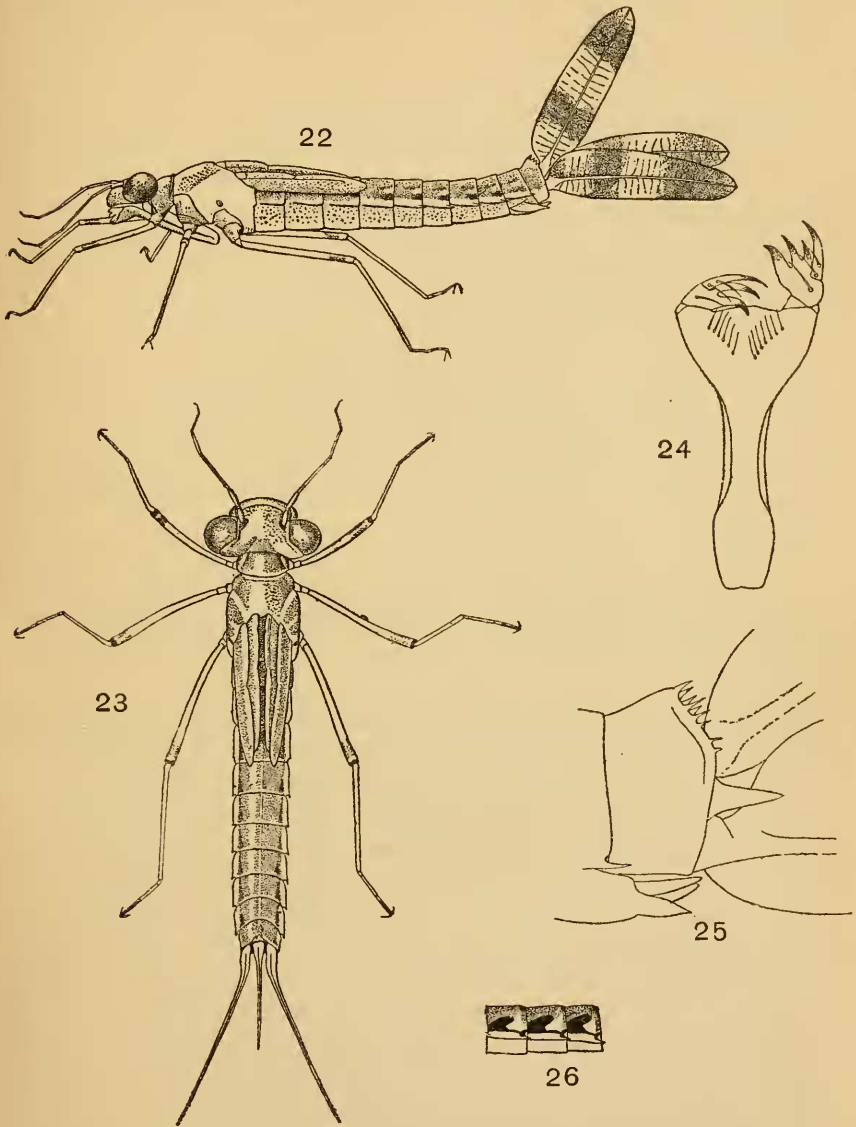
the metallic tints, while the sides of segments 9 and 10 become bluish pruinose.



FIGS. 16-21.—*ARCHILESTES CALIFORNICA*. 16. OVIPOSITING. 17. IN COPULATION. 18. SCARS FROM OVIPOSITION, ONE YEAR OLD. 19. SCARS TWO YEARS OLD. 20. BARK CUT AWAY SHOWING EGGS IN CAMBIUM. 21. EGG.

Female (figs. 3 and 4).—Coloration identical with that of the male, both in teneral and mature imagoes, except that in the female the hind pair of legs are usually less heavily striped and segment 9 of the abdomen is black above as in segments 2-8.

Figure 15 shows a dorsal view of the appendages of a typical male *grandis* from Guatemala. Just above it, figure 5, is a drawing to the same scale of a male *californica* taken on Satus Creek. The



FIGS. 22-26.—*ARCHILESTES CALIFORNICA*, NYMPH. 22. LATERAL VIEW. 23. DORSAL VIEW. 24. LABIUM. 25. ABDOMINAL SEGMENT 10. 26. COLOR OF A LIVE PALO ALTO, CALIFORNIA, SPECIMEN.

slight differences in greater convexity of the outer rim of the appendages of the Satus specimen with the other minute peculiarities noticeable occur in about the same degree in all the Satus material.

Calvert¹ writes that in a large series of Mexican and Central American material such slight intergrading differences are to be found, but Doctor Ris, after comparing a series of the Yakima specimens with the series of *grandis* in his collection, considered *californica* a good species.

Figures 6 and 7 show ventral and lateral views of the male appendages.

As *Archilestes* is a peculiar genus and contains only these two species, I have taken this opportunity to figure some of the grosser anatomical peculiarities. Figure 9 shows the chitinized parts of the sexual apparatus in the second segment of the male, lateral view. The dorsal or inner arm of the penis is held by a single pair of heavy supports. The parts supporting its inner tip are not chitinized. The external tip of the penis has a small, fleshy, ventral lobe and a large, almost circular, disc-shaped dorsal lobe. (See figs. 10 and 11.) A ventral view of the second segment in the male is shown in figure 8.

Figure 13 shows the mesostigmal lamina of the female, which is rather complex. Figure 12 shows the prothorax of the female, which does not differ from that of the male. Figure 14 is a lateral view of the ninth and tenth segments of the female abdomen with their appendages.

Archilestes in the Yakima Valley is an autumnal insect. When it first appears, the following summer species are disappearing: *Agrion aequabile yakima*, *Argia emma*, *Argia vivida*, *Ophiogomphus severus*, *Aeshna multicolor*, *Macromia magnifica*, *Libellula forensis*, and *Platthemis lydia*.

The first specimens of *Archilestes* were taken July 27. These were few in number and all very teneral. On August 3 perhaps as many as a hundred were seen in the willow glades branching from the main channel of the creek, and on August 7 *Archilestes* were common. The breeding season for *Archilestes* lasted, then, until about September 14, when several frosts occurred and collecting did not begin until 10 o'clock in the morning and was practically over at 2 o'clock. At this date the only other dragonflies on the wing were *Lestes congener*, *Ischnura perparva*, *Ischnura cervula*, *Aeshna palmata*, *Aeshna umbrosa occidentalis*, *Sympetrum pallipes*, and *Sympetrum vicinum*. At this late date *Lestes congener*, *Archilestes californica*, *Aeshna palmata*, *Aeshna umbrosa occidentalis*, and *Sympetrum vicinum* were at the height of their season. Six weeks later stragglers of these species were still on the wing along Yakima River.

During August, or until active breeding began, the individuals of this species with wings held loosely open were usually found hanging on the leaves and stems on the sunny side of willow and alder bushes. Here each appeared to have its favorite position, from which it would

¹ Calvert, P. P. The Odonata of Baja California, Mexico. Proc. Cal. Acad. Sci., ser. 2, vol. 4, 1894, p. 555.

fly up and out a distance of 6 to 10 feet from time to time to take passing insects, returning each time to its resting place. On being disturbed none ever hesitated to dart into the densest portion of the bush on which it rested. Many, especially teneral, rested on grass, and such when attacked flew into the nearest bush. Even fully developed imagoes were never on the wing for any great length of time, seldom at any time flying more than 20 or 30 feet; but in spite of their apparently weak flight they were not easily taken, because a single stroke with the net would send all the near-by individuals into the bushes.

On September 7 it was observed that they were more abundant about the willow-fringed pools than formerly, where many couples were now flying from bush to bush. On both September 7 and September 14, which was the last date on which collecting was done on the creek, oviposition was in progress.

In capturing the female the male flies toward her while she is on the wing, or if she is alighted, as is the usual case, she flies up to meet him, when he first seizes her head with his feet, then bending his abdomen forward, seizes her prothorax with the claspers on the tip of his abdomen. She usually copulates at once, which is a lengthy process, the pair in copulation restlessly wandering from place to place. (See fig. 17.)

After many minutes in copulation they settle down on a vertical willow twig from one-fourth to one-half an inch in diameter overhanging some pool, or which may be even 3 feet back from the water and at a distance of from 2 to 10 feet above the surface of the water, and begin the tedious process of oviposition. (See fig. 16.) The male holds the female during oviposition. The female draws the tip of her abdomen up until her body forms a loop with the ovipositor between her legs, when she makes in the willow branch a downward thrust. On examination of twigs it was found that no egg is laid in this first downward thrust. Next she partly withdraws the ovipositor, making a lateral thrust on the right side. This is for the first egg. A third thrust is made in the same side by partially withdrawing the ovipositor first and aiming it forward of the second. A fourth thrust is made forward of the third for the third egg. Then she twists the tip of the abdomen around, making three thrusts on the left side, the lower thrust first, the upper thrust last. In each of the six lateral thrusts an egg has been laid with the small dark end at the point of insertion. (See figs. 20 and 21.) After such a series of eggs has been laid the female withdraws her ovipositor and the pair back down the branch about one-fourth of an inch and repeat the process. One pair was watched for an hour, at the end of which time the female took longer rests between thrusts and finally ceased ovipositing.

The eggs probably pass the winter in the live cambium tissue of the twigs, for in a twig I kept alive until January 1, 1914, the eggs were yet unhatched. While traveling with it the twig died, so further observations were impossible. As the eggs are laid in bushes which in the floods of spring snow water would be partially submerged, the hatching nymphs probably find their way easily into the water. After laying, the puncture made by the ovipositor of the female closes, so that during the following winter it is found with difficulty, but in the second season of the scar it appears as a small hole surrounded by the circle of dead bark under which lay the six eggs. (See fig. 18.) With further growth this circular scar does not heal, but widens laterally so that a series of puncture scars in their third season appear as a series of lenticular depressions in the growing twig. (See fig. 19.) Many twigs are killed by being girdled with puncture scars. These seem to disfigure alder bushes more often than willows, perhaps because of the slower growth of the alder. The older scars run in series of from 12 to 30 in number. With 6 eggs deposited in each scar it would appear that the female lays from 70 to 180 eggs before tiring.

While ovipositing the pair are remarkably indifferent to enemies, as both can be easily picked up by the hand.

Though I watched carefully I found only one place along the creek where ovipositing took place. This was in the alders and willows along a scum-covered stagnant pool of the creek. Such pools occurred about two to every mile. This was fringed by a thick growth of *Juncus* and *Scirpus*, on the smooth stems of which were found many exuviae of *Archilestes*. These were from 2 to 12 inches above the surface of the water. The bottom of this pool was covered with soft mud and the water was filled with floating masses of filamentous algae, but though I spent an hour raking this pool for nymphs I found none.

Nymph.—The nymph of *Archilestes grandis* (?) has been described by Needham¹ from Arizona specimens, but as my nymphal skins differ in certain minor characters from his description, I have indicated these differences.

The most noticeable difference is in size. They are in all measurements about one-fourth smaller than the Arizona nymphs. The following are the measurements of the Satus specimens: Length, including gills, 28–31 mm.; gills, 9–10; abdomen, 14–15; hind femur, 6; antenna, 6; width of head, 5; width of abdomen, 3.

These Satus specimens (see figs. 22–26) are among themselves very uniformly marked and differ in certain points from Needham's description of Arizona nymphs. The main points of their coloration

¹ Needham, James G. New dragon-fly nymphs in the United States National Museum. Proc. U. S. Nat. Mus., vol. 27, No. 1371, pp. 685–720, pls. 38–44, 11 figs, May 20, 1904. See pp. 712–713, pl. 42, fig. 3.

are as follows: The abdomen (see fig. 26) below the lateral keel is uniformly pale. Above each lateral keel is a narrow white stripe, jogged at the end of each segment as is the lateral keel. There is a small black apical spot on the side of each segment just above the lateral white line. Above each black spot is a white spot. The remainder of the dorsum of the abdomen is uniformly dark except a narrow middorsal stripe. Gills (see fig. 22) with outer two-fifths dark and a narrower band across the second fifth from the base. Legs (see fig. 23) with two narrow dark bands at apex of femur.

Thus the *Satus* specimens, as pointed out before, in being an isolated brood of *Archilestes* and perhaps the northernmost outpost of this southern genus, show a racial integrity in the following points: (1) Small size of nymphs and imagoes; (2) lack of metallic coloration; (3) shape of male appendages, and (4) coloration of nymphs.¹

2. A NEW SPECIES OF DRAGONFLY OF THE GENUS ARGIA, ITS LARVA AND THE LARVA OF ARGIA VIVIDA.

On July 31, 1910, while collecting along the Yakima River near the Mabton Bridge, I took for the first time several pairs of a large *Argia*, the males of which were of a rich violet color. At this point the river was shallow, muddy bottomed, and stagnant. The *Argias*, in company with *Enallagma cyathigerum*, *Ischnura perparva*, and *Ischnura cervula*, were flying about and resting on a small patch of *Potamogeton*. I tried at first scooping them with my net in order to keep the net dry, but failed. Success came only when they were slapped into the water, potamogeton, net, and *Argia*. My first meeting with them showed that they were quick, nervous, and unusually wary.

I saw no others until August 13, 1911, when I found them very abundant on the gravelly beaches and stony riffles of lower *Satus* Creek. It was soon evident that on gravelly ground it was practically impossible to catch them, as the uneven surface of the gravel permitted them to dodge under the edge of the net. During the two hours I had at my disposal for collecting, I succeeded in taking less than a dozen specimens, though they were very abundant.

None were collected during 1912, but during the past summer (1913) I managed to carry out an extended campaign of collecting on *Satus* Creek, making 11 trips, though the creek is 18 miles from the ranch.

Satus Creek drains that part of the Yakima Valley which lies between the Simcoe Mountains and the brown, barren Horse Heaven

¹ Just recently in San Jose and at Napa, California, I have had opportunity to observe the live *Archilestes* nymphs. They are very free swimmers, and on being disturbed swim into the open water like a school of minnows, which I thought they were when I first saw them. This habit accounts for my failure to capture any by raking. Emergence had just begun at Napa on June 9. Here the nymphs were very abundant in the ponds on the State Hospital grounds.

Hills. This is an elevated plateau cut into table-like buttes by the narrow and abrupt canyons of Satus Creek and its tributaries. This arid region slopes rapidly northeast from the Klickitat Mountains on the west to the Yakima River, so that, in its length of 60 miles from the eastern spurs of the Klickitats to the Yakima River, Satus Creek has a fall of about 3,500 feet. This is one of the most arid regions of the Yakima Valley, having an annual rainfall of less than 10 inches, which with its rapid slope makes it so dry that it is a red and brown region with its naked surface but little relieved by the soft gray of sage bushes. Because of this aridity Satus Creek is dependent for its water on the melting snows of the Klickitat Mountains, which give it a flood in May and June, while it becomes almost dry from July to October.

The past summer's collecting was done on the lower portion of the creek where Satus Canyon opens out onto the greasewood flats of the Yakima River. The soil of this flat is from 5 to 10 feet deep, below which is gravel. In crossing this flat Satus Creek has cut down through the superficial layer of soil, so that it flows over the surface of the gravel, having thus made an earth-walled channel 200 feet wide, the floor of which is an almost continuous succession of gravel bars. During flood the creek occupies the full width of the channel, but during summer it dwindles to a 10 second-foot stream meandering among the gravel bars of its flood bed. While the greasewood flat is destitute of trees, the creek itself is marked by the green line of willows, elders, alders, and balsam trees, which have gained a foothold on the older gravel bars within the flood channel.

On June 17, 1913, when I made my first trip to Satus this season, I searched carefully for *Argias*, but found none. The creek was still at a medium stage, being about knee-deep on the riffles, though many of the higher gravel bars were exposed. On June 26 *Argias* were common, especially on those gravel bars grown up thickly with young willow sprouts, for none appeared at first on the more exposed bars and riffles. Many of these were beyond the teneral stage. At this time there were flying on the creek *Agrion aquabile*, which had been on the wing but a few days, *Enallagma cyathigerum* which was at the height of its season, *Enallagma carunculatum* at the beginning of its season, *Ischnura perparva* common, *Ischnura cervula* less common, *Amphiagrion saucium* scarce and at the end of its season, *Ophiogomphus severus* common and in perhaps the third week of its season, *Ophiogomphus occidentis* rare, *Aeshna californica* at the end of its season, *Aeshna multicolor* common, *Sympetrum madidum* at the beginning of its season, *Erythemis simplicicollis*, *Libellula pulchella*, *Libellula forensis*, and *Plathemis lydia*. On this earliest date the *Argia* males were chasing the females and some were flying around

in couple, but I saw none copulating or ovipositing. A month later the species had reached its greatest abundance. The creek then was low; not more than 15 second-feet of water was flowing. *Argias* were abundant on the gravel bars and exposed gravel-strewn riffles, and among the pink willow roots oviposition was in progress. On August 8 the *Argia* was yet the most abundant species, but by August 24 the number was less than one-fourth its previous maximum. On September 7 only two *Argias* were seen, and on September 14 none were found. Its season had ended as the autumnal species were reaching their height, *Archilestes californica*, *Lestes congener*, *Ischnura perparva*, *Aeshna palmata*, *Aeshna umbrosa occidentalis*, and *Sympetrum vicinum* being the only species on the wing. Some individuals emerged as late as August 7, though none were noticed on later dates.

The following is a description of this *Argia*, which was found to be undescribed and which I have named for my mother, who has ever encouraged my interest in entomology.

ARGIA EMMA, new species.

Figs. 27-30, 35-36, 39-41, 48, 50-51, 54-61, 65-70.

This is a large species of *Argia*, but is not as robust as *Argia vivida*. It is a species not brilliantly marked, and is comparatively free from pile.

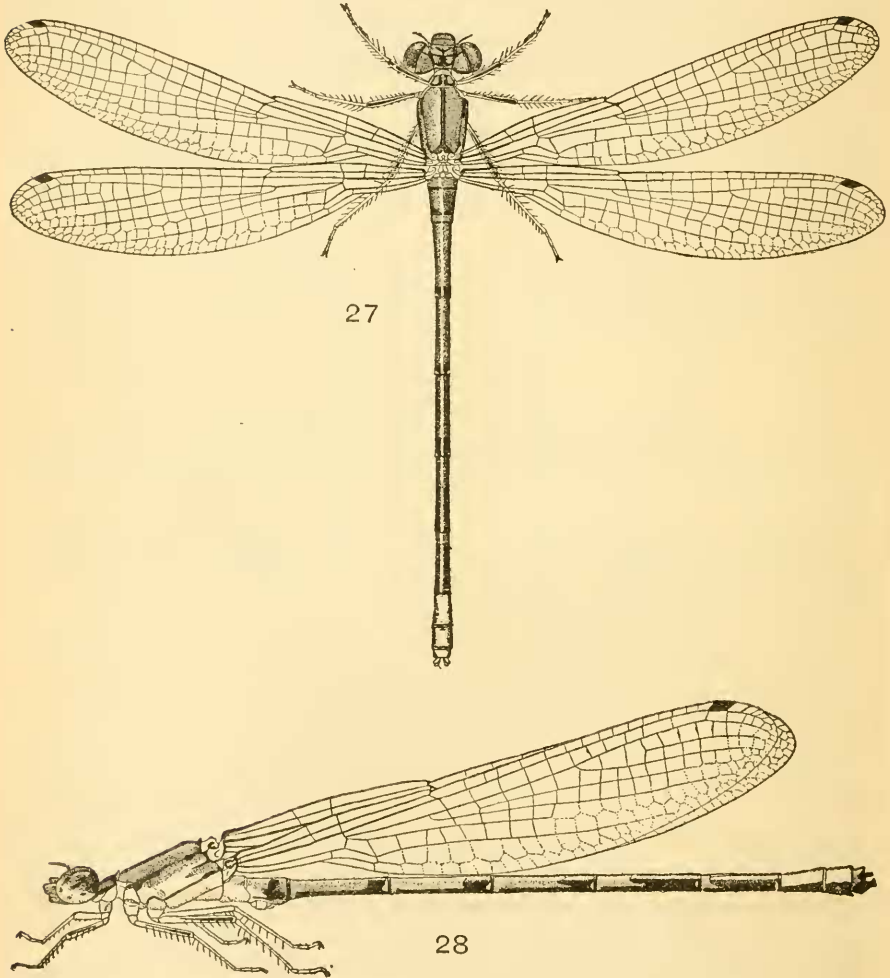
Length of abdomen: Male, 27-31 mm.; average, 29.1; female, 27-32; average, 29.35. Length of hind wings: Male, 21-24; average, 22.75; female, 22-25; average, 23.2.

Type.—Cat. No. 19038, U. S. N. M. A male, from Satus Creek, Yakima County, Washington, August 7, 1913.

Allotype.—Cat. No. 19038, U. S. N. M. A female from Satus Creek, Yakima County, Washington, August 7, 1913.

Male.—Thorax robust, abdomen slender. Legs long, the last femora reaching to the second abdominal segment. Wings noticeably narrower than in the female, and in the fully colored specimens with a faint bluish or steely sheen. Stigma surmounting only one cell, which is usually larger than the stigma. Among 20 males tabulated, the usual number of antenodal cells was 4 in each fore wing and 3 in each hind wing. Variations of one or two occurred either way. The average for the fore wings in the 20 examples was 3.9 and for the hind wings 3.3. The male illustrated in figure 27 was not included in the 20 tabulated. In the accessory genitalia are peculiarities which are probably specific. (See figs. 50 and 51.) The ventral limb of the anterior hamuli, i. e., the horizontal ventral edge, is high and thin compared with the same in *vivida*, where it widens cephalad. The posterior hamuli are rounder, when viewed ventrally, than in *vivida*. The most marked peculiarities occur in the penis, which

in this species is very simple. It consists of a long chitinized proximal joint folded on itself, which carries at its distal end two lateral fleshy lobes, which are thin dorso-ventrally. Arising between the distal ends of these and curving ventrad and cephalad, then dorsad, is the curved tip of the penis, which is supported by two chitinous ribs. This tip, as compared with the complexly lobed tip of the

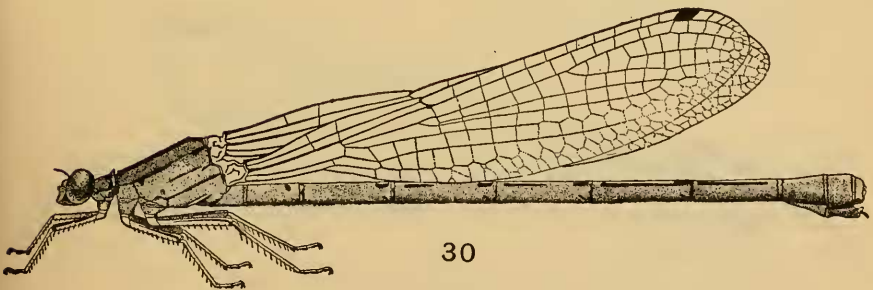
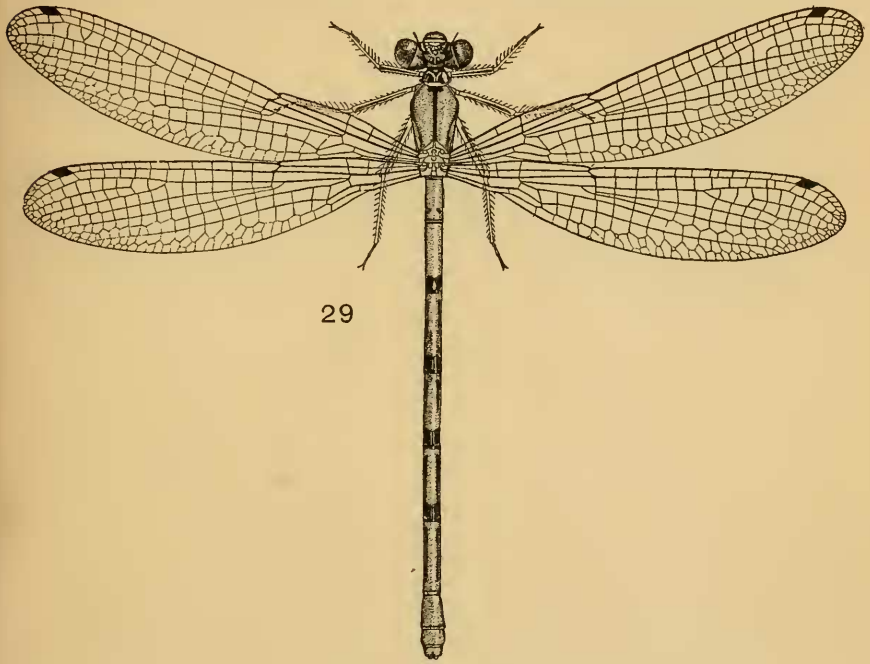


FIGS. 27-28.—*ARGIA EMMA*, MALE. 27. DORSAL VIEW. 28. LATERAL VIEW.

vivida penis, is simple in construction. The lateral walls of the genital fossa, when viewed from the side, are almost straight, when compared with the abrupt ventrad development of the posterior half of the walls in *vivida*.

Segment 10 of the abdomen deeply and narrowly indented on the median dorsal line of the posterior end, and with a high keel on either side of this indentation. (See figs. 39-40.) The superior appendages

two-thirds the length of the inferiors; when viewed from above, each is curved inward for its first half, then *rounded outward*, and terminates in two short points, both of which lie in the same horizontal plane, and are directed laterally. The superiors when viewed laterally show the distal end terminating in a blunt point directed ventrad.

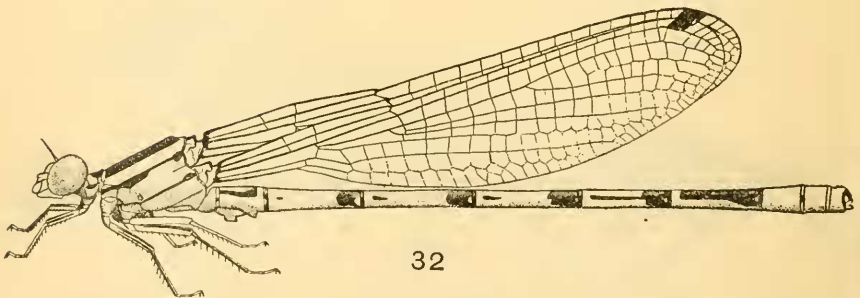
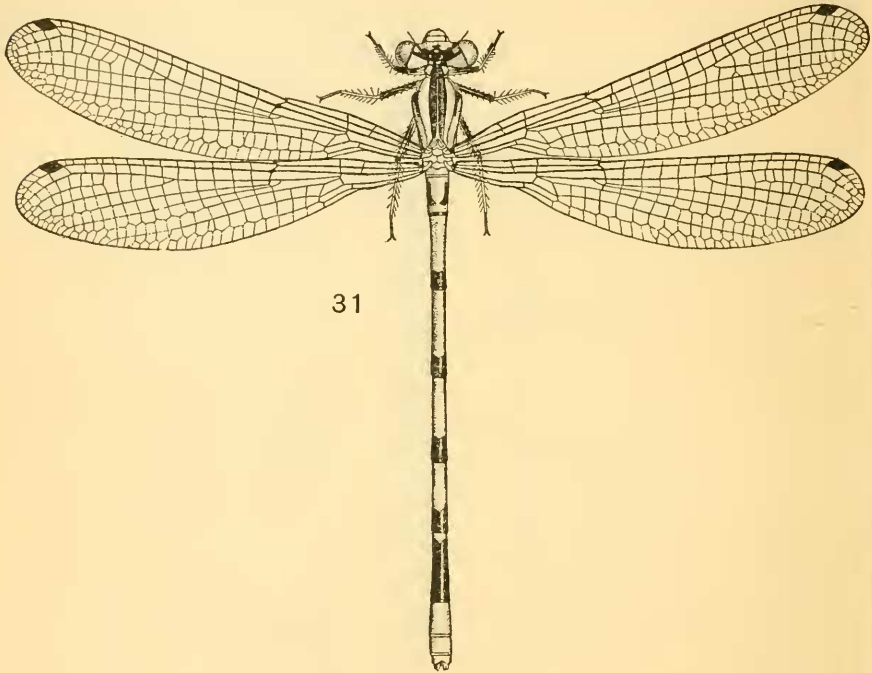


FIGS. 29-30.—*ARGIA EMMA*, FEMALE. 29. DORSAL VIEW. 30. LATERAL VIEW.

In the inferior appendages the distal branch is short and rounded, and, when viewed from above or below (figs. 40-41), is seen to be decurrent on the inner edge of the appendage as an ill-defined ridge. The other or lateral branch, when viewed from above or below, is semi-circular in outline, and is directed caudad and laterad at an angle of 45° and when viewed from behind is seen to be directed upward at an

angle of 45° . It has an obscure rounded tooth on its outer anterior edge. Some pile occurs on the appendages but not enough to obscure them. The minute spines on the posterior edges of the segments are long as compared with the short blunt spines of *vivida*.

In Doctor Calvert's *Argia* key in *Biologia Centrali-Americana*, Odonata (p. 72) the species *emma* runs to *funebria*, but it differs

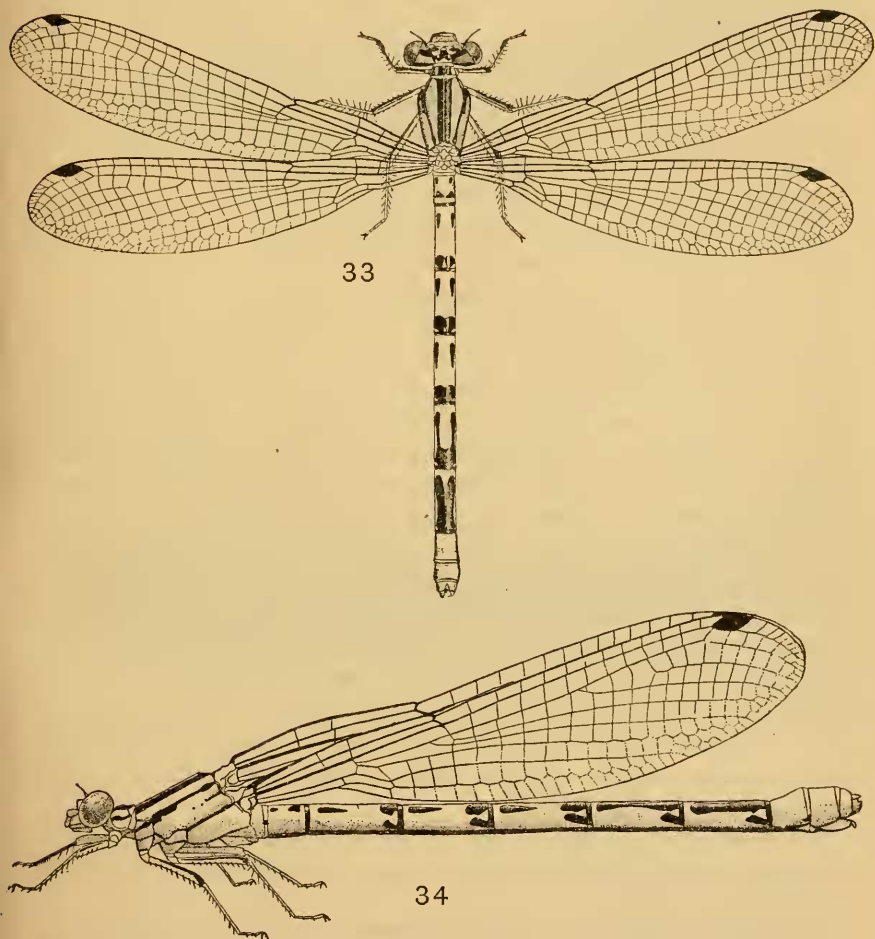


FIGS. 31-32.—*ARGIA VIVIDA*, MALE. 31. DORSAL VIEW 32. LATERAL VIEW

sharply from *extranea*, *vivida*, or *funebria* in the shape of the superior abdominal appendages of the male, the apices of which turn *outward* instead of inward. Figure 42 is a tracing from figure 59 of plate 4 of the *Biologia Centrali-Americana*, Odonata, which was drawn by Calvert from the unique type in the Museum of Comparative Zoology. Figures 43-44 are copies of Doctor Hagen's drawings of the same

type-specimen of *funnebris*, which were published.¹ I have not seen the type myself. I am not well enough acquainted with the genus *Argia* to risk a guess as to whether *emma* falls naturally in the *extranea-vivida-funnebris* group or not. The superior appendages of the male seem to exclude it, as do marked differences between the larvae.

In reproducing wings for the illustration, figure 27, I unfortunately reproduced wings which were freakish in that the fore wings have but



FIGS. 33-34.—*ARGIA VIVIDA*, FEMALE. 33. DORSAL VIEW. 34. LATERAL VIEW.

two antennodal cells each. Furthermore it seems to be the only male in the series so veined.

Male, live color.—Labrum, clypeus, nasus, frons, vertex, post-ocular areas, and occiput rich violet. Gena lighter, almost pink. Ocelli brownish. Antennae black. A black line connecting each antenna with the anterior ocellus. (See figs. 55-57.) A T-spot

¹ Calvert, P. P. Illustrations of Odonata: *Argia*. By Hermann A. Hagen. Bull. Mus. Comp. Zool., vol. 39, No. 4, pl. 1, figs. 4-4a, November, 1902.

extending forward from the anterior ocellus. The ocellar area and the area between the ocelli and the vertico-occipital suture black. Suture between either end of the occiput and its postocular area black. From each anterior angle of the occiput a black line extending forward to its corresponding antenna, and a narrow line extending laterally to its corresponding eye. Postocular areas edged posteriorly with black. Labrum, clypeus, frons, and occiput covered with long white pile, which is longest on frons. Eyes very dark violet above, almost black, shading into grayish violet below. Under surfaces of head pale violet, covered with scattering white pile.

Prothorax violet above. Sides and coxae brownish with a heavy coating of pruinose. The tergo-pleural sutures black; a broad black line at the base of the posterior lobe connecting the posterior ends of the tergo-pleural lines; a black line along base of anterior lobe connecting the anterior ends of the tergo-pleural lines. Anterior edge of anterior lobe black. A narrow longitudinal middorsal violet stripe bounded on each side by a black stripe. Posterior lobe not marked.

Mesothorax and metathorax with dorsal surfaces violet, shading into brownish on lower-lateral and ventral surfaces; the brownish areas heavily pruinose. Middorsal carina narrowly black, one-fourth width of either antehumeral pale streak, the black extending around the edges of the antealar sinuses. Dorsal third of mesinfrapisternum black. Humeral suture black, as follows: A rectangular black spot below its anterior end, from which a broad line extends dorsad to its middle point, where it tapers to one-third its previous width, extending thus narrowed to the dorsal fourth, where it abruptly widens for the remainder of the suture. Dorso-posterior edge of mesepimeron and upper third of first lateral suture black. Dorso-posterior edge of metepisternum and second lateral suture black. Femora pale brown with a heavy external and a heavy anterior black stripe, between which lies a high brown keel. Tibiae with an antero-interior black stripe. Spines black. Tarsi dark brown. Wings hyaline, stigma dark brown.

Abdomen with segments 1-7 violet with black sterna; segments 8, 9, and 10 blue with black sterna, and abdominal appendages black. (See figs. 27 and 28.)

Segment 1 with sides and sternum brown overlaid with pruinose.

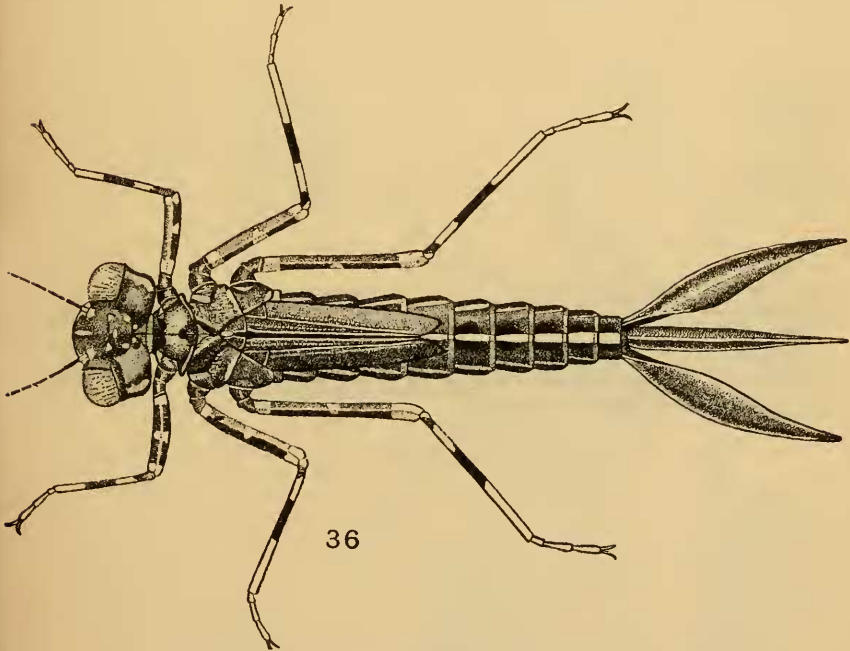
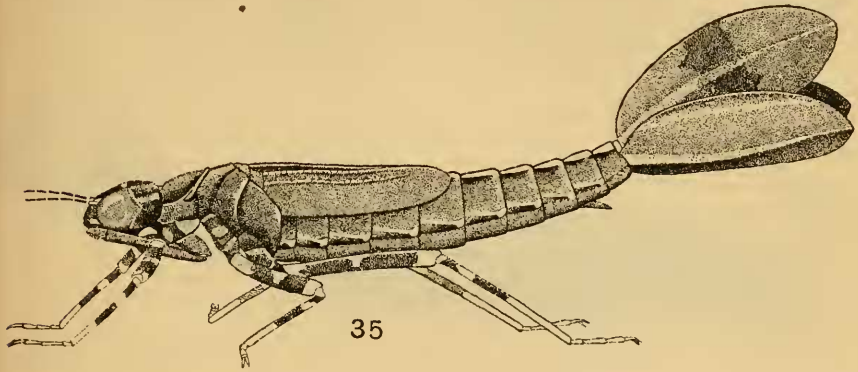
Segment 2 with a lateral round-lobed, inverted T-spot on the posterior half, followed by a narrow band encircling posterior end.

Segment 3 with a narrow line along ventral edge of pleurite. A narrow band around posterior end, just in front of which is a second broader band encircling the segment, but running obliquely down and forward.

Segment 4 marked similarly to segment 3, but with the broad oblique band occupying the posterior fourth of the segment.

Segment 5 similar to segments 3 and 4, but with the broad band occupying the posterior third of the segment.

Segment 6 similar, but with the broad band occupying the posterior half of the segment.



FIGS. 35-36.—*ARGIA EMMA*, NYMPH. 35. LATERAL VIEW. 36. DORSAL VIEW.

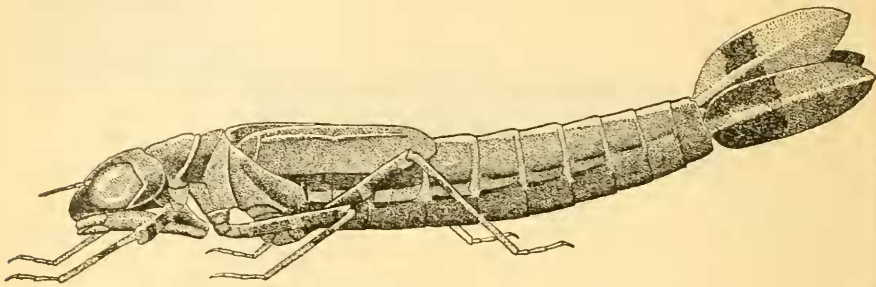
Segment 7 similar, but with the broad band occupying the posterior three-fourths of the segment. In segments 6 and 7 the anterior edge of this broad band shades out so that the anterior edges lack definition.

Segments 8 and 9 blue with a black stripe along ventral edge of pleurite, wider on segment 9 than on segment 8.

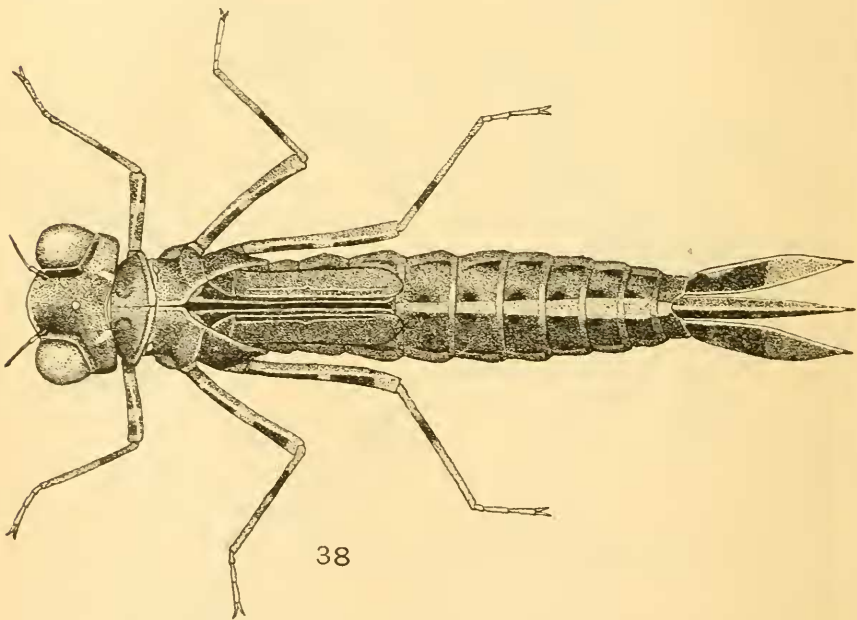
Segment 10, upper half blue, lower half black, the dividing line running ventrad and anterad. Appendages black, lighter around bases and on inner surfaces of inferiors.

The general is a cream or light tan color. It changes through light brown into a light brownish violet, and finally into violet; later the under parts become pruinose.

Female.—Slightly larger than the male, and especially the abdomen more robust. Wings slightly longer. Among 20 females tabulated the tendency in number of antenodal cells was to a slightly greater



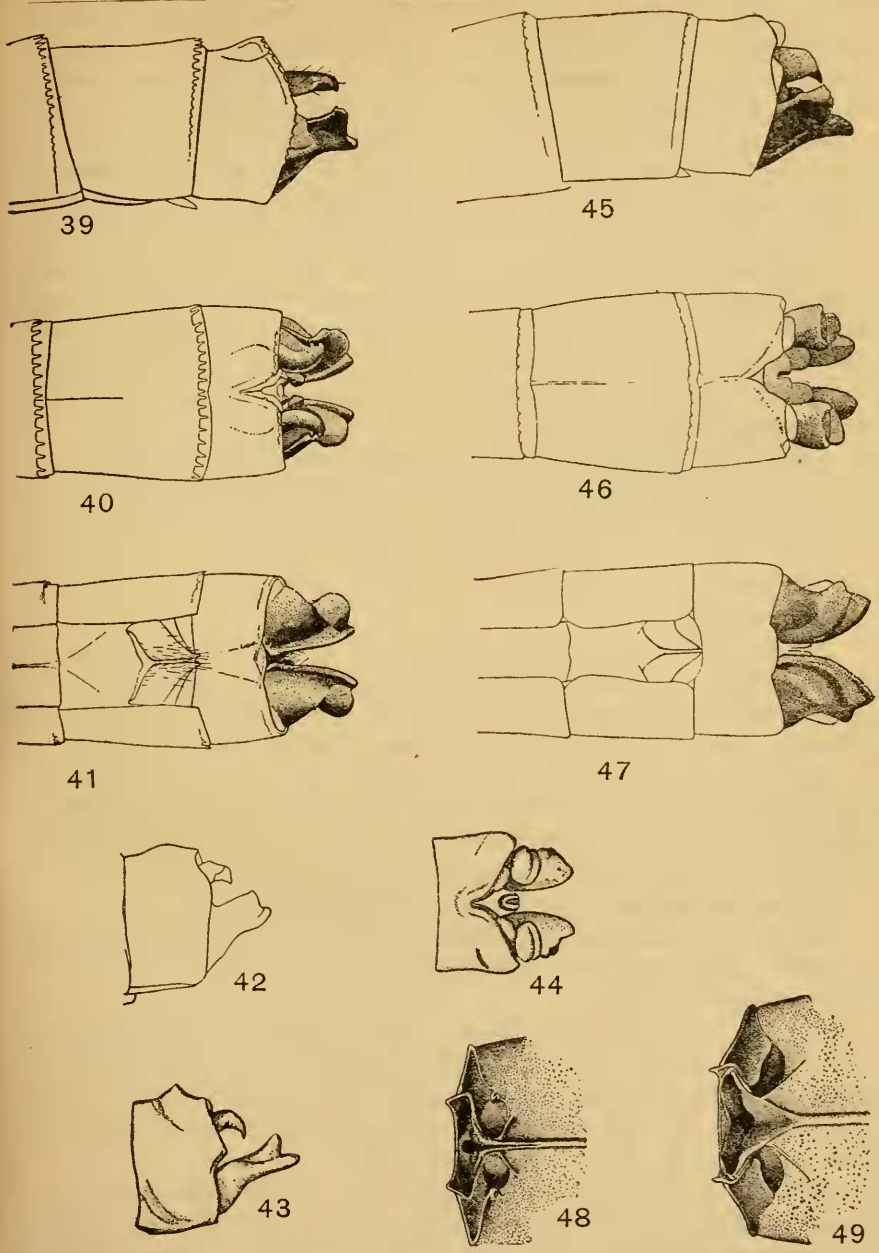
37



38

FIGS. 37-38.—*ARGIA VIVIDA*, NYMPH. 37. LATERAL VIEW. 38. DORSAL VIEW.

number than in the male. Two of the 20 had 5 cells in each fore wing and had 4 cells in each hind wing. The averages were, right fore wing 4.1, left fore wing 4.1, right hind wing 3.6, left hind wing 3.4. Legs long, the femora of the anterior pair reaching the second abdominal segment. The best diagnostic character is the shape of the mesostigmal laminae, the minute organs on either side of the anterior end of the middorsal carina, which appear to have a form peculiar to the



FIGS. 39-41.—*ARGIA EMMA*, ABDOMINAL SEGMENTS 9 AND 10. 39. LATERAL VIEW. 40. DORSAL VIEW. 41. VENTRAL VIEW.

FIG. 42.—*ARGIA FUNEBRIS*, MALE ABDOMINAL SEGMENT 10, LATERAL VIEW, COPIED FROM CALVERT.

FIGS. 43-44.—*ARGIA FUNEBRIS*, MALE ABDOMINAL SEGMENT 10, COPIED FROM HAGEN. 43. LATERAL VIEW. 44. DORSAL VIEW.

FIGS. 45-47.—*ARGIA VIVIDA*, MALE ABDOMINAL SEGMENTS 9 AND 10. 45. LATERAL VIEW. 46. DORSAL VIEW. 47. VENTRAL VIEW.

FIG. 48.—*ARGIA EMMA*, FEMALE, MESOSTIGMAL LAMINAE.

FIG. 49.—*ARGIA VIVIDA*, FEMALE, MESOSTIGMAL LAMINAE.

females of each species of *Argia*. By referring to figure 48 it will be seen that the whole organ (formed of the anterior end of the middorsal carina and the two laminae) is narrow antero-posteriorly, that the mid-dorsal carina ends in it abruptly, instead of widening out into a broad triangle as in *vivida*, and that the two postero-lateral depressions are less sharply defined than in *vivida*. The minute spines on the posterior edge of the abdominal segments are long and slender as in the male.

Female, live color.—In some females in advanced age the color is a slate blue. Teneral are as in the male (see figs. 60 and 61), a light tan or creamy white, changing then through darker shades of brown to olive, and in some specimens, perhaps 5 per cent, of those captured to a further stage of slate blue. In drying, the blue specimens change to an olive brown. The females may be dichromatic, as both blue and brown females oviposit.

Female, blue form.—Labium and labrum brownish gray; clypeus, nasus, frons and vertex, bluish slate. Postocular areas pale gray. Under surfaces of head brownish. Eyes grayish brown above and whitish below. Head sparingly covered with white pile. Markings on the head same as described for male, and showing the same individual variation.

Prothorax bluish slate above, brownish on the sides, and heavily pruinose below. Markings same as described for the male.

Mesothorax and metathorax strikingly blue on anterior and dorsal surfaces, also on sides to below humeral suture. Lower sides and ventral surfaces pale olive brown overlaid with pruinose. Legs light brown and pruinose, less heavily striped than in the male. All other thoracic markings same as described for the male. Wings hyaline, lightly flavescent in some individuals; stigma cream.

Abdominal segment 1 pruinose. (See figs. 29 and 30.)

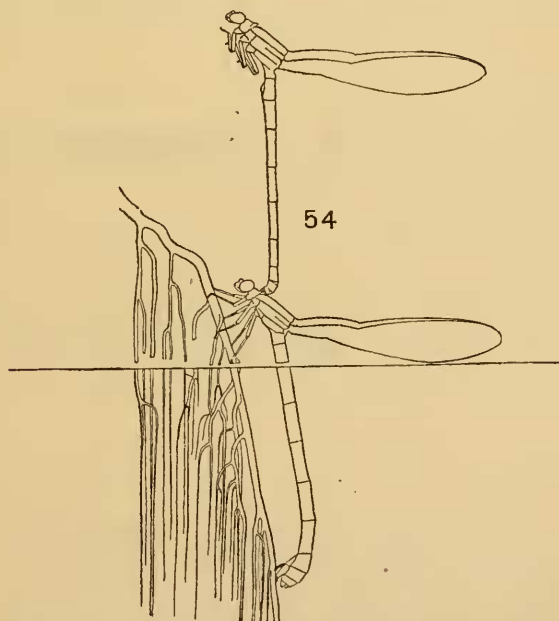
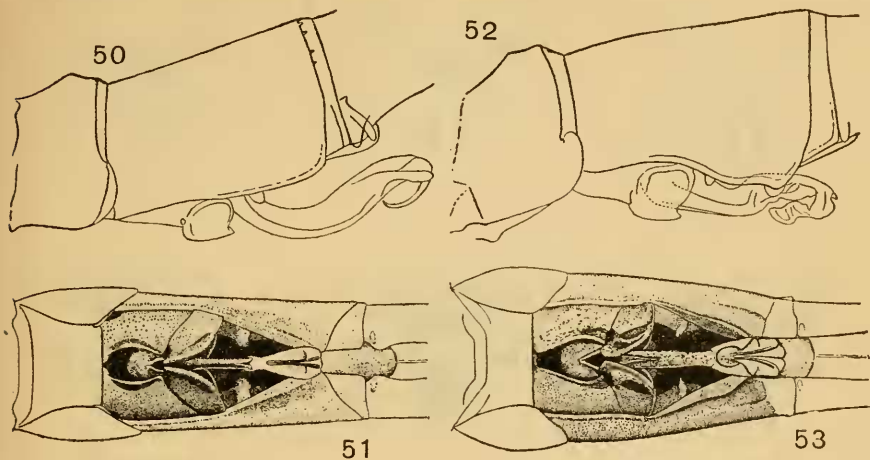
Segment 2 blue with an olivaceous cast. A narrow black ring around its posterior end. Two small oval spots on the dorsal surface of the posterior third.

Segment 3 very blue, the bluest of the abdomen. A narrow black ring around its posterior end. On either side a narrow oblique spot running ventrad and caudad in the extreme ventro-posterior angle of the pleurite. On the posterior end of the dorsal surface a U-shaped spot opening cephalad.

Segment 4 less blue than segment 3. As in segment 3, a narrow band around the posterior end, and a narrow oblique spot running ventrad and caudad in the angle of the pleurite. A narrow stripe, broader cephalad, running along either upper side. These stripes¹ begin from the anterior end of the segment at about twice the width of the posterior bands, and terminate at the middle of the segment. On the posterior end of the dorsal surface a U-shaped spot, but with

¹ These stripes are termed by Calvert in the *Biologia Centrali Americana*. "post-basal streaks."

the arms of the U so broad that the internal opening is reduced to a line, while the external anterior angles of the arms of the U are rounded.

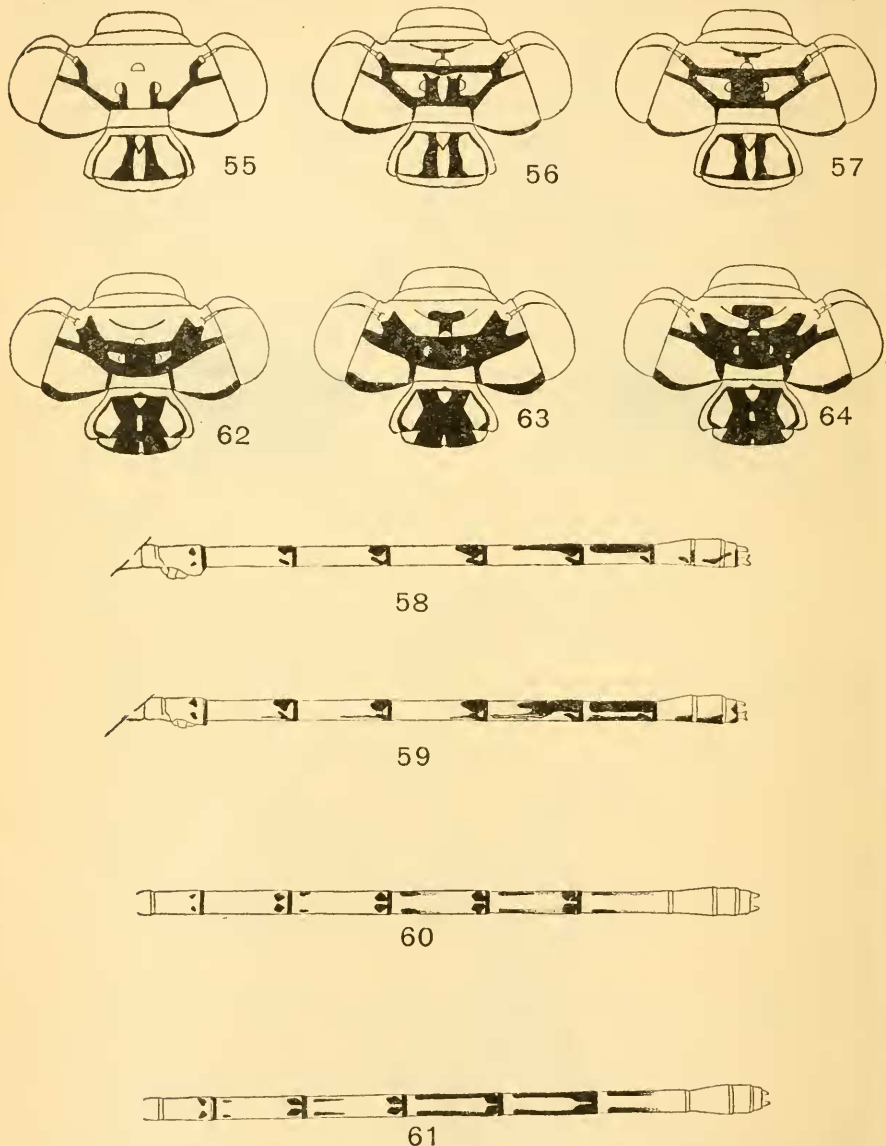


FIGS. 50-51.—*ARGIA EMMA*, MALE ABDOMINAL SEGMENTS 1 AND 2. 50. LATERAL VIEW. 51. VENTRAL VIEW.
 FIGS. 52-53.—*ARGIA VIVIDA*, MALE ABDOMINAL SEGMENTS 1 AND 2. 52. LATERAL VIEW. 53. VENTRAL VIEW.
 FIG. 54.—*ARGIA EMMA*, OVIPOSITING.

Segment 5 less blue than segment 4, but with the same color pattern.

Segment 6 olivaceous. Color pattern same as in segments 4 and 5, but with each dorso-lateral stripe confluent posteriorly with its arm of the dorso-posterior U-spot.

Segment 7 a medium brown color. Color pattern similar to that of segments 4, 5, and 6, except that the dorso-posterior spot is wanting,



FIGS. 55-61.—*ARGIA EMMA*. 55-57. MALE, MARKING ON HEAD AND THORAX. 58-59. MALE, MARKING ON ABDOMEN IN TENERALS, LATERAL VIEW. 60-61. FEMALE, MARKING ON ABDOMEN IN TENERALS, DORSAL VIEW.

FIGS. 62-64.—*ARGIA VIVIDA*, MALE, MARKING ON HEAD AND THORAX.

and the two dorso-lateral stripes extend caudad to the posterior fifth of the segment.

Segments 8, 9, and 10 a medium brown with no markings.

Ventra of segments 3-8 black, of segments 1, 2, 9, and 10 brown.

Female, brown form.—The larger number of females are of this color, which is as follows: Labium and labrum gray; clypeus, nasus, frons, and vertex pale reddish brown. The postocular areas the most reddish of any part of the insect. Eyes pale brown above, brownish gray below. Antennae black.

Prothorax pale brown above, lighter below. Legs pale brown.

Mesothorax and metathorax yellowish brown on dorsal and anterior surfaces. Coxae and trochanters same shade, femora and tibiae pale brown. Wings hyaline, stigma almost white.

Abdominal segments 1-7 brownish olive gray, shading into brownish on segment 8. Segments 9 and 10 pale grayish brown.

All markings same as described for the blue female.

The system of markings in *Argia* seems to be a generic character, as it occurs with various modifications from sex to sex and species to species. The more generalized pattern occurs on the females (see figs. 29, 30, 33, 34, 60, and 61). The coloration of the males is more widely divergent, but is understood when its evolution from the "female form" in the male teneral is considered (see figs. 58 and 59, of male teneral *emma*).

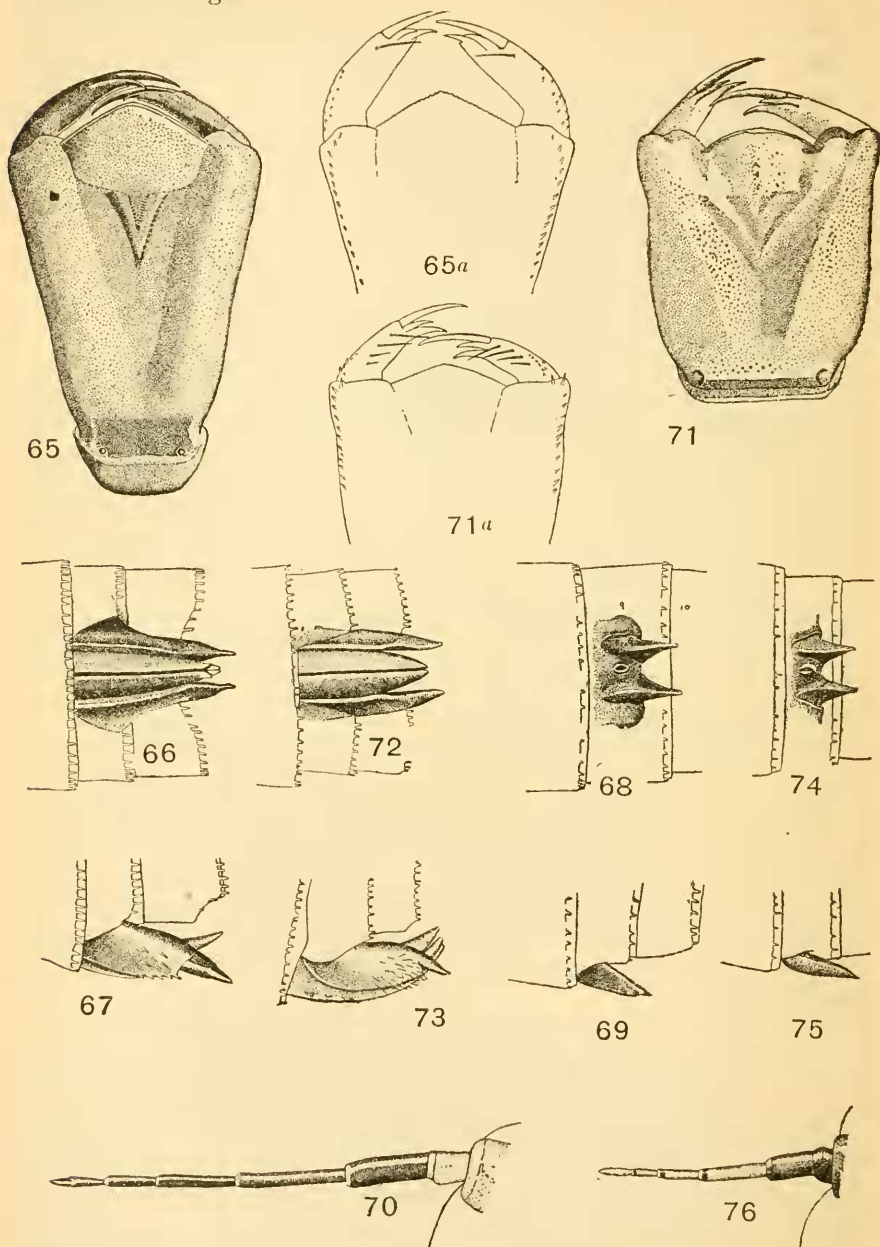
Nymph (figs. 35, 36, 65-70).—This is a vigorous, long-legged and contrastingly colored nymph with large gills.

Length of abdomen, without gills, 12 mm.; length of gills, 5; width of head, 3.5; length of hind leg, 11. The specimens are shrunken from having been put into strong alcohol.

Head broader than long, the posterior margin noticeably emarginate. Five round white dots between the compound eyes (the 3 ocelli and 2 other similar white dots). A broad white stripe on each postocular lobe. Antennae longer than head, slender, base and first joint white, the remaining joints black. Mentum $1\frac{1}{2}$ times as long as broad; posterior edge one-half as wide as anterior margin; ligula angular. Each lateral lobe with a single raptorial seta just below the base of the movable hook, a notch separating the end hook from the inner margin.

Prothorax more than twice as broad as long, the ridge around the posterior edge very prominent, and running down on to the side to the coxae. Dorsal surface strongly convex with a median groove. Femora of first pair of legs three-fourths as long as femora of second pair. Mesothorax and metathorax equal and either slightly longer than the prothorax. A deep concavity extending from anterior point of anterior wing pads to mesinfraepisternum. Femora of second legs extending beyond the posterior margin of abdominal segment 4. Tubercle between the upper edge of mesinfraepisternum and posterior edge of prothorax drawn out dorso-ventrally, making a low vertical ridge. Posterior pair of wing pads extending to posterior edge of

abdominal segment 4. Femora of last pair of legs extending to posterior side of segment 5.



FIGS. 65-70.—*ARGIA EMMA*, NYMPHAL DETAIL. 65. LABIUM, VENTRAL VIEW. 65a. LABIUM, DORSAL VIEW. 66-67. VULVA. 68-69. ABDOMINAL SEGMENT 9 OF MALE. 70. ANTENNA.

FIGS. 71-76.—*ARGIA VIVIDA*, NYMPHAL DETAIL. 71. LABIUM, VENTRAL VIEW. 71a. LABIUM, DORSAL VIEW. 72-73. VULVA. 74-75. ABDOMINAL SEGMENT 9 OF MALE. 76. ANTENNA.

Abdomen dark, with a white middorsal stripe, narrower anteriorly and widening caudad until widest on segments 9 and 10, where it is

bordered on each side with intense black. A low lateral keel on segments 1-8 (not conspicuous on segments 7 and 8). A narrow, jogged white stripe dorsad of either lateral keel. The lateral gills are very spoon-shaped and in fresh material variously banded with black.

Male with the two points on the sternum of segment 9 slightly longer and more attenuate than in *vivida*. (See figs. 68-69.)

Female with the two outer or ventral members of the ovipositor shorter than the dorsal or inner pair. (This is true also in *vivida*, but only for the immature nymphs.) The genital valves, especially the posterior points, vary greatly in shape. In this species they are usually conspicuously toothed, especially on the distal half of the ventral edge. (See figs. 66-67.)

Male, a skin collected August 3, 1913, on Satus Creek, Yakima County. (On the same date I collected a male in the act of emerging, but the skin blew into the water, damaging it too much for a type specimen.) Deposited in the United States National Museum.

Female, collected on Satus Creek, June 29, 1913, reared, emerging between July 2 and 10, while I was in Oregon, during which time the teneral drowned, being badly decayed on my return. Skin and imago deposited in the United States National Museum.

About 20 specimens, including both skins and nymphs, were collected during 1913. The nymphs of this species are not easily found, as they roam over the whole creek bed and so are never numerous in any single place. They are usually found in the roots and brush of the larger pools and under large stones on the riffles. On turning a stone over the nymph is usually on the bottom beneath the stone and hurrying away. This is a noticeable difference between this nymph and that of *vivida*, which is usually hanging back down from the stone picked out of the water, and very sluggishly arouses to the fact that it should hunt shelter. The agility of the *emma* nymph permits it to live in the swift riffles and contest for existence with the crayfish and stonefly and mayfly nymphs. It is the only odonate nymph found in the swift riffles of Satus Creek.

Emergence, judging from the finding of tenerals, takes place any hour of sunlight after the middle of the morning. The nymph usually crawls up on a stone, seldom more than an inch above the water. On August 3, 1913, I found an *Argia* emerging. It had crawled up on to a smooth pebble lying in the middle of a shallow riffle, where I found it at 9.52 in the morning an inch above the surface of the water, with head, thorax, and legs already withdrawn. It was clasping the head of the skin with its frail feet. It was a grayish cream color. In a minute it moved its legs in a tentative manner, then quickly crawled up on the stone just in front of the head of the skin, but with the tip of the abdomen still retained in the skin. In a

minute more it crawled farther up the stone, freeing the tip of the abdomen, and continued to move about with nervous, jerky steps.

At 9.55 it was twice the length and size of the skin, and the wings had begun to lengthen. In the lengthening of the wings the bases lengthened first and the tips last. The wings were then three-fourths of an inch long, increasing in two minutes more to five-eighths, and were clear except the costal margin beyond the nodus. All during emergence the teneral rapidly and incessantly moved the body up and down. At 9.59 the wings were 1 inch long, and in another minute were clear. The abdomen during expansion of the wings remained the same length as when first withdrawn, but at 10.04 it began to lengthen, the expansion beginning with the anterior segments; at 10.09 the abdomen equaled the wings; at 10.12 it was one-fourth inch longer than the wings. At 10.15 the teneral, still a grayish cream color, crawled nervously to the top of the stone and flew weakly to a willow 30 feet distant. In two minutes after the teneral had withdrawn its abdomen from the skin a light gust of wind had blown the skin into the water. The fact that most of the larvae emerge on the riffles probably accounts for the few exuviae found, as the stones there are round and smooth, permitting the skins to be detached by the first puff of wind.

The teneral stage probably lasts a day or two, during which the insect avoids the opposite sex, and does not trust itself over the surface of the water. Tenerals are usually found in the bushes along the banks.

I have never seen this species hanging in copulation, as is common among Odonata. Its actions are so nervous and rapid that I am not certain that I have ever seen it copulate. From my observation of many pairs I think copulation is as follows: The male in flying about and trying various females finally finds one in a receptive state. As he swoops down on her she flies up, when he seizes her for a second by the head or thorax with his feet, instantly throwing the tip of his abdomen forward and seizing her by the prothorax. If he fills his seminal vesicle during this process he does it the instant before he seizes her prothorax with his abdomen.¹ The very simple structure of the accessory genitalia of segment 2 would indicate rapid action. As the male releases the female from his first or foot grasp and straightens his abdomen the female swings her abdomen forward and

¹ In my mind it is a question whether the male dragonfly necessarily fills his seminal vesicle while grasping the female. I have watched for the act of filling the seminal vesicle, but in several years collecting have seen but one instance where I felt sure that I had seen the act. On Sept. 7, 1913, while collecting on Satus Creek, I saw an *Aeshna* (either *palmata* or *umbrosa occidentalis*) swoop at a female flying close alongside a dense thicket and miss her. He then rose vertically a distance of about 12 feet to pass over the thicket, during which rise he had his abdomen bent forward with the ventrum of segment 9 attached to segment 2. He was easily observed because of the dark background of foliage, and because, flying vertically or "back first," he rose slowly. As he cleared the top of the thicket he straightened his abdomen and speeded away. The whole process of filling the vesicle occupied less than three seconds.

apparently copulates for only a second. I have seen several different females swing the abdomen forward for barely a second or so, but am not yet positive that it is a completed copulation. These seizures take place more commonly in the morning. If these seizures are not copulatory, then copulation would seem to take place but once or twice in the life of the female instead of daily and oftener as in the higher Odonata, for if daily I would surely have observed at least some single instance, for I was on the creek early and late and from the beginning of the season watched for copulation. During the afternoon numerous females seated on stones in the riffles refuse the approaches of all males. In refusing a male, the female, as the male swoops down on her, flies up and takes a position just above the male's head, where she flies for several feet until the male gives up and turns away. This species spends many hours in couple, the male holding the female by the prothorax and both seated on some sunny stone.

Oviposition must occupy but a small part of the time of the female, as on a stretch of 2 miles on Satus Creek I found only one small area where oviposition took place frequently. This was among the pink roots of willows which hung in a shallow side pool through which a small stream flowed. Oviposition is a lengthy process, the female sometimes working alone, but usually held by the male, who supports himself solely by his hold on the female, and, scorning other support, stands stiffly out of the water with his wings folded and his legs drawn tightly against his thorax until the female backing down into the water submerges him with her. (See fig. 54.)

The Argias, while spending all day close to the water, seldom leaving the riffles and bars, leave the water just before sundown and spend the night in the shrubs along the creek, where they are to be found early in the morning. The two ways to capture them with moderate ease is among the bushes early in the morning, or at the height of their season to stand in the water facing a high bank or dense bush, where they are passing, and capture them as they fly past between the collector and the bank or bush.

As to enemies, I have not seen birds capture Argias, but I have seen an *Erythemis simplicicollis* eating a teneral. There are few frogs along the creek; in fact the Argias seem to flourish with few enemies except crayfish and such others as prey on the nymphs. I have never found this species infested with red mites.

I have never found this species else than on the Yakima River and lower Satus Creek.¹

¹ Since writing the foregoing I have found *Argia emma* common on the larger rivers of central California and on the Truckee and Humboldt rivers in Nevada. It occurs from sea level on the San Lorenzo and Sacramento rivers to 6,000 feet elevation on the Truckee River at Lake Tahoe. Professor Farr, of Sunnyside, Washington, has recently sent me a series of specimens from Union Flat Creek, Pullman, Washington.

ARGIA VIVIDA Hagen.

Figs. 31-34, 37-38, 45-47, 49, 52-53, 62-64, 71-76.

The second half of this section deals with *Argia vivida* and includes a description of its nymphs. *Argia emma* and *Argia vivida* are the only Argias I have found in the Columbia watershed.

Argia vivida has been found in three localities, all of which agree in certain particulars.

In June I made a four days' drive to the falls of Logie Creek, which is the main tributary of Satus Creek. I succeeded in getting down to Logie Creek in two places and down to Dry Creek, which is the main tributary of Logie, in one place. This is an exceedingly difficult region to explore in a buggy. The single wagon trail runs up hill for 60 miles, following the surface of the ancient slope, with the creeks rushing down through canyons 500 feet below the level of the road.

On June 15 I found *Argia vivida* very abundant on an area of not over an acre in extent about 15 miles above the mouth of Logie Creek. The road at this place went down into Logie Canyon through a short lateral ravine. The bottom of the canyon opened out at this point, making a small flat of about 2 acres in extent, which was covered with grasses, with here and there scrub oak trees, and along the creek its usual line of alders, back from which stretched thickets of rose and sumac bushes. At one end of this flat a spring oozed out at the base of the cliff, and its stream, trickling down through the alder thicket, contained many *vivida* nymphs. The shade, as usual in an alder thicket, was dense, but *Argia vivida* in couple were resting in profusion on the bushes, dead brush, and rocks, which filled this stream. Teneral were numerous as well as males in high color and a few females in full color, but I saw none copulating or ovipositing. This spring stream was not over 100 feet long, and its bed and sides were of black muck, from the leaves which fall into it annually. Scattered over the bed were rounded stones up to 12 inches in diameter, to the under sides of which the *vivida* nymphs were clinging. The spring water was cold and the nymphs were sluggish. Exuviae were found clinging to the stones but an inch or two above the surface of the water. *Argia vivida* is a comparatively sluggish insect and seemingly very local or restricted in its choice of environment. Argias were very abundant on the ground in the open spaces of the flat near this spring stream, but were not found farther than 150 feet from it. In couple they hung to bushes when hovering about the stream, because the bushes overhung the water, giving them little choice, but outside in the sunshine they sat mostly on the bare ground or on stones or sticks lying on the ground. They were easily taken by approaching carefully and slapping the net over them or scooping them with the net. They were associated here with *Sympetrum madidum* and an *Aeshna*,

probably *californica*, which I took on Dry Creek not many miles distant.

I next found *Argia vivida* at Sherman, Oregon, which is on the Columbia River about 2 miles east of the mouth of the Deschutes Canyon. The Columbia Gorge at this point is from two to three thousand feet deep. Its sides are massive brown hills, with here and there solitary green ranches on spring-fed benches a thousand feet above the river. Its bottom on either side is a narrow strip of white sand dunes lying between the gravelly beach and the foot of the hills. Among these sand dunes is the box-car railroad station called Sherman, Oregon. Opening into the gorge about 1 mile west of the station is a narrow canyon, which is occupied by the Y of the Deschutes road. Through this canyon trickles a small stream arising from numerous springs, which meanders in the mouth of this canyon through a succession of swampy and rocky holes. This stream swarms with *Argia vivida*. They sat on the stones along the stream, and because of the numerous rocks, and the heat, were difficult to catch. The constant west wind blowing up the Columbia Gorge had carried many of the *Argias* as far up as the Sherman station. They were associated in this side canyon with *Amphiagrion saucium* (very abundant), *Ischnura perparva* (common), *Ischnura cervula*, *Enallagma cyathigerum*, *Anax junius* (seen on the wing), *Ophiogomphus occidentis* (on the Columbia beach), *Sympetrum corruptum* and *Libellula forensis*.

The third place I found *Argia vivida* was on lower Satus Creek. On August 24, 1913, I took 10 specimens around a scum-covered spring-fed side channel of Satus Creek. This small spot agreed with the other two in being a cold spring-fed but stagnant stream. Perhaps these were descendants of strays from farther up the creek.

Numerous specimens of both sexes from both Logie Creek and Sherman, Oregon, were heavily infested with red mites, in which respect it differs from *emma*, which I have never found infested.

This species differs also from *emma* in that frequently when pursued it will dodge into bushes or other vegetation, where an *Argia emma* would fly for the open.¹

The following descriptions of the adults are for comparison with *Argia emma*. The color notes are from live specimens and alcoholic material.

DESCRIPTION.

This is a large and robust species of *Argia*, sluggish in comparison with *emma*, and, as its name implies, brilliantly colored.

Length of abdomen: Male, 26–30 mm.; average, 27.8; female, 24–29; average, 27. Fore wings slightly longer than hind wings. Length

¹ Throughout California and Nevada *Argia vivida* occurs in all permanent springs, and while imagoes are occasionally caught on streams and ponds such can usually be traced to near-by spring streams. I have taken it from sea level to 6,000 feet altitude (Lake Tahoe).

of hind wings: Male, 20-23; average, 21.7; female, 22-24; average, 23.3.

Male.—Robust, both thorax and abdomen. Legs compared with *emma* short and weak, the last femora barely reaching the first abdominal segment. Wings relatively shorter than in the female but not noticeably narrower; hyaline but not as steely as in *emma* males. Stigmas variable; among 20 males the stigmas of the front wings in 11 surmount one cell; in 2 individuals the stigma surmounts 2 cells in one front wing and one cell in the other front wing; in 7 individuals the stigmas surmount variously from $1\frac{1}{4}$ to $1\frac{3}{4}$ cells. The same variation shows in the stigmas of the hind wings. Among 20 males tabulated the usual number of antenodal cells was 4 in each fore wing and 3 in each hind wing. Variations of one or two occurred either way. The average in the 20 males was right fore wing 4, left fore wing 3.8, right hind wing 3.1, and left hind wing 3.1.

In the second segment of the abdomen (see figs. 52 and 53) the ventral limb of the anterior hamule is thicker anteriorly, and about a third of its length back of the anterior end this thickness forms an obscure ridge decurrent dorsad on the base of the hamule. Viewed ventrally the posterior hamules are more pointed than in *emma*. The ventral limb of the chitinous shaft of the penis has on its ventral surface at the anterior end a ridge, which widens cephalad; the posterior third of the ventral limb is slightly narrower than the anterior two-thirds. The second joint of the penis extends caudad from the distal end of the basal joint or shaft; it is fleshy and widens caudad, and when viewed laterally is seen to be variously folded and ridged. The third or terminal segment runs cephalad; it is supported by two chitinous longitudinal ribs, and consists of an almost quadrangular proximal lobe, occupying two-thirds of its length, each outer distal angle of which is indented on its lateral face, and a distal or terminal elliptic lobe. The lateral walls of the genital fossa when viewed from the side are extended more abruptly ventrad in their posterior half than in *emma*.

Segment 10 deeply and widely indented on the dorso-median line of the posterior end, with a low keel on either side of this indentation. (See figs. 45-47.) The superior appendages two-thirds the length of the inferior; when viewed from above, widening caudad and abruptly truncate, the posterior end appearing impressed. When viewed from behind it is seen that this impressed area is produced ventrad and slightly caudad into a single median tooth. When viewed from the side the dorsal and ventral edges are seen to be subparallel, and the ventro-posterior tooth appears in profile extending ventrad and in some specimens slightly caudad. Each inferior appendage has a lateral and a terminal branch which are subequal. When viewed from above the terminal lobe is seen to be obtusely pointed and when viewed from below it is seen to be decurrent along the inner edge of the appendage as an

obscure keel. Lateral lobe extends laterad, dorsad, and slightly caudad, broad but terminates abruptly in a blunt point. Very little pile.

Male, live color.—Labium, labrum, clypeus, nasus and frons light blue. Vertex darker blue with traces of violet. Eyes dark blue above with lighter blue below. Color pattern of top of head same as in *emma*, but with all the lines heavier (fig. 62), in some of the specimens coalescing into a solid spot, as is shown in figures 31, 63, and 64. White hairs on labrum, frons and occipital region. Antennae black.

Prothorax blue above, lighter blue on the sides and with the coxae and ventral surfaces very light. A line along the base of the anterior lobe connecting at each end with the line along the upper sides, which lateral lines connect posteriorly with the black line along the base of the posterior lobe. Two broad dorsal lines connecting the anterior and posterior lobes, and extending caudad across the posterior lobe. These lines are separated by a hair line of blue. Trochanters with an outer black spot. (All markings are black unless otherwise stated.) Femora blue with an anterior and an exterior stripe separated by a high pale keel. Tibiae blue with an anterior stripe from which arises the anterior row of spines. Tarsi black.

Mesothorax and metathorax blue, darker dorsally and anteriorly, bluish gray ventrally. A very wide middorsal black stripe, one-third wider than either pale area bordering it. Mesinfraepisternum with its dorsal half black. Humeral suture heavily marked as follows: Lower or anterior half broad, upper or posterior half narrow except an abrupt enlargement at upper end. In occasional specimens the humeral stripe is broad and of uniform width. First lateral suture not marked. Second lateral suture narrowly marked, but with an abrupt, round enlargement at its upper end. Coxae and femora bluish gray, tibiae blue, tarsi black. Markings of middle legs similar to those in the fore legs but not as heavy and yet lighter in the hind legs. Wings hyaline, neither bluish nor flavescent. Stigma dark brown.

Abdomen with segments 1-7 intense blue above with sternum of segment 1 brown and sterna of segments 2-7 black. Segments 8-10 lighter blue with brown sterna. Markings as follows (see figs. 31 and 32):

Segment 1 with minute lateral black spot on its posterior edge.

Segment 2 with a narrow band around its posterior end. On either side above, a narrow stripe almost the length of the segment, with the posterior end turning dorsad.

Segments 3, 4, and 5 marked as follows: A broad band around the posterior end of the segment. A small spot above on either side of the anterior end of the segment.

Segment 6 similarly marked, but with either anterior spot connected with the posterior band by a line running caudad. (In some

specimens segment 6 is marked similarly to segments 3, 4 and 5.) The posterior bands contain on either side a blue triangle.

Segment 7 with a heavier development of the color pattern than on segment 6, making the entire dorsal half of the segment black except a narrow blue band across the anterior end.

Segment 8 pale blue with a minute spot on each latero-posterior edge.

Segment 9 pale blue with posterior edges and appendages variously marked with black.

The teneral color of the male is a pale gray or chalky white. In changing from the chalky white to the intense blue the male passes through brown, brownish violet, and violet blue stages.

Female.—More robust than the male, especially the abdomen. Wings relatively longer than in the male, which when folded reach to the middle of segment 8 and occasionally to middle of segment 9; hyaline but with a decided flavescence. Stigma rarely surmounting more than one cell. Wings not proportionally broader than in the male. Among 20 females tabulated, the usual number of antenodal cells was 4 in each fore wing and 3 in each hind wing, with variations of one either way. The average in the 20 females was, right fore wing 3.9, left fore wing 4, right hind wing 3.1, and left hind wing 3.1.

Legs short, the last femora reaching the first abdominal segment. Mesostigmal laminae large (see fig. 49); the anterior end of the mid-dorsal carina prolonged between them into a wide triangular enlargement, and each mesostigmal lamina extended posteriorly in a plate or ridge, which overhangs its respective postero-lateral depression.

Female, live color.—The females of *Argia vivida* are more variously colored than any sex of any odonate species I have seen. As in the male, the teneral is a chalky white, which changes through various shades of gray-violet and brown into a high color largely blue, which gives the female the general appearance of the male in high color. This blue color was rare, as I found few specimens in it, but I took most of my *vivida* series early in their season. Of four females taken on lower Satus Creek on August 24, only one was blue.

Female, blue form.—Labium brownish gray; labrum grayish blue; clypeus, nasus, frons and vertex greenish blue slate. Occiput and postocular areas blue with a tinge of violet. Markings of the head same as described for the male with the same individual variations. Eyes blue above, shading into violet gray below (in one high colored female my notes mention, "eyes violet gray"). Scattering white pile on the labrum, frons and nasus, also on the postocular areas and occiput. Antennae black.

Prothorax with dorsal and lateral surfaces blue; ventral surface and coxae pale brownish; femora gray; tibiae pale grayish blue. All markings as in the male.

Mesothorax and metathorax blue, more intense on the anterior surfaces, shading into violet gray on sides and under surfaces. Coxae and femora violet gray; tibiae greenish blue. Legs and thorax marked as in the male. Stigmas pale brown. Wings hyaline with a suggestion of flavescence; stigma brown.

Abdomen, ground color blue, an intense blue on dorsal surface shading into a more violet blue on the sides of segments 1-7. Sternum of segment 1 brown and of 2-7 black. Dorsal and lateral surfaces of segments 8, 9, and 10 pale blue. Markings as follows (see figs. 33 and 34):

Segment 1, on either side a minute spot at the posterior end.

Segment 2 with a narrow black band around posterior end. At anterior end a small spot above on either side. At posterior end a larger spot, triangular (sometimes quadrangular or even elliptic) above on either side.

Segment 3, a narrow band around the posterior end. At the anterior end above on either side, a small spot attenuate caudad. At the posterior end a larger spot on either side, but with the inner anterior angles coalesced across the middorsal line, and the posterior ends touching the posterior band. (These large paired posterior spots are homologous with the U-spots on the abdomen of the *emma* females.) In each lower posterior angle of the pleurite an oblique stripe running dorsad and cephalad for one-fifth the length of the segment.

Segments 4 and 5 marked like segment 3, but with the markings successively heavier until in segment 5 the two posterior dorsal spots are coalesced into a heart-shaped mark with the apex pointing caudad.

Segment 6 marked like segment 5, but with the two antero-dorsal spots attenuate caudad until their posterior ends coalesce with the anterior points of the heart-shaped postero-dorsal marking.

Segment 7 with markings similar to the preceding, but with the four dorsal spots enlarged and coalesced into a large V-marking, which when viewed from above resembles an old fashioned clothespin with the head pointing caudad.

Segment 8 with a minute spot in the lower posterior angle of the pleurite.

Segments 9 and 10 without markings.

As stated previously, the teneral ground color is a chalky white. The first change is to a brownish violet along the dorsal surface of the abdomen. Then the eyes become grayish violet and segments 8, 9, and 10 become pale blue. The chalky gray of the entire body then takes on a pale brownish tint with suggestions of violet on the abdomen and femora. The majority of the females collected were

in this violet and brown stage with segments 8, 9, and 10 blue, which I believe is the usual breeding color.

Nymph.—(figs. 37, 38, 71-76).—A short nymph with very dark color, and color pattern very obscure except the broad white stripe down the middorsal line of the abdomen. Caudal gills small and legs weak.

Total length, not including gills, 12 mm.; length of abdomen without gills, 7; length of gills, 3; width of head, 3.6; length of hind leg, 7.5. Head broader than long, the posterior margin almost straight, being very slightly emarginate between the postocular lobes. Antennae (see fig. 76) short, their length less than length of head; base and first two joints black, the four distal joints white with obscure darker rings. (These markings fade very soon in alcohol.) Mentum short and broad, almost square; anterior margin of ligula slightly convex. Four raptorial setae on each lateral lobe, the anterior setae as long as the end hook, the others successively shorter. The end hook is not separated by a notch from the inner margin as in *emma*. (See figs. 71 and 71a.)

Prothorax twice as broad as long. Ridge around posterior edge not prominent. Dorsal surface flat except a minute semicircular depression on the anterior portion. Femora of first pair of legs two-thirds as long as femora of second pair. Tibiae of first pair almost as long as tibiae of second pair.

Mesothorax and metathorax equal and either slightly longer than the prothorax. A deep concavity extending from the anterior point of the anterior wing pads to the mesinfraepisternum. A short tubercle between the upper edge of the mesinfraepisternum and the posterior edge of the prothorax. Posterior wing pads extending to the posterior edge of abdominal segment 3. Femora of last pair of legs extending to middle of segment 4.

Abdomen widest in segments 4 and 5 which are only slightly less wide than thorax. A low lateral keel on segments 1-7 (inconspicuous on 7). Abdomen very dark, with a very conspicuous white middorsal stripe, which is narrow cephalad and widens caudad until it is widest on segment 9 (all other abdominal markings obscure). The middorsal stripe bordered by dark. A light irregular stripe associated with each lateral keel, which is edged above and below by darker. The lateral gills less conspicuously spoon-shaped than in the *emma* nymph, the prominent rib making them more roof shaped.

In the male the two points on the abdominal segment 9 are shorter and more pyramidal than in the *emma* male. (See figs. 74, 75.)

Female with the two outer or ventral members of the ovipositor as long or longer than the upper or inner pair (except in immature larvæ). The genital valves roughened on the distal half of the ventral edge, any teeth being hidden by long hairs. The posterior tips

of the genital valves vary greatly, not giving reliable characters. (See figs. 72-73.)

Of the two nymphs, *vivida* is covered with a fine pubescence, while *emma* larvae are almost entirely free from pubescence.

Described from a male, collected June 15, 1913, on Logie Creek, Yakima County, Washington; reared, emerging June 25, 1913; skin and imago deposited in the United States National Museum. Also described from a female, an alcoholic nymph collected June 15, 1913, on Logie Creek, and now deposited in the United States National Museum.

The only place I have collected *vivida* nymphs is on Logie Creek at the place previously described. There on June 15, 1913, I took 42 nymphs varying in length from 3 mm. to 12 mm. Nine of these were in the mature stage. The other 31 on examination and measurement seemed to fall into two groups, which probably were a 1914 brood and a 1915 brood. As there were great differences among those of the youngest brood this may have represented two broods instead of one. I have not reared the female and have reared only two males.

3. NOTES ON ISCHNURA CERVULA AND ISCHNURA PERPARVA.

These notes were undertaken at the direct suggestion of Mr. E. B. Williamson, who thought that descriptions of the live colors of these species would be of value, especially in reference to any dimorphism in the coloration of the females.¹ In view of the present confusion among the described species and varieties of *Ischnura* from the Pacific slope, these notes have been made to include points other than color.

The two species are widely distributed over Washington and Oregon. Wherever I have found one of the species, the other, though perhaps not so abundant, has always been found. Both reach their greatest abundance around the alkaline ponds of the upper Sonoran Zone, but occur commonly and in some places abundantly in the Transition Zone. I have never found them in the Canadian Zone, but I have done very little collecting at that altitude. I have specimens of both species from the following localities: Oregon—Baker Valley, elevation 3,400 feet; Eagle Valley, 2,500 feet; Deschutes Valley (Bend, Oregon), 4,000 feet; Columbia River Gorge (Sherman, Oregon); Washington—Kittitas Valley, elevation 2,500 feet; Yakima Valley, 700 feet; Spokane Valley, 3,000 feet; Palouse Valley.

Both are all-season species, being on the wing from the first open spring weather until heavy frosts occur in the autumn. Both are

¹ I wish to thank Mr. E. B. Williamson for his constant help and encouragement, as it is he who started me and has sustained my interest in this work.

seldom found far from the weedy banks of a pond or stream and both are found about either alkaline ponds or fresh running water. However, *cervula* seldom occurs abundantly except around alkaline ponds.

ISCHNURA CERVULA Selys.

Figs. 77-80, 87-91, 94-100, 106-109, 117-121, 127-132.

While occurring from early spring till heavy frosts in the autumn, *Ischnura cervula* reaches its greatest abundance during the months of May and June. About running water it is scarce, in such places choosing the more stagnant spring laterals and side ponds. As with the other species of the genus, it is seldom found over the water or on land far from the moist banks of a pond or stream.

It emerges in the daytime, usually between 9 and 11 o'clock in the morning, when it can sometimes be found emerging in swarms. At such times the nymphs can be seen swarming to the bank with a tadpole-like wriggling motion. They usually wait about 15 minutes after crawling from the water until they dry and the back splits. A half hour later they are on the wing. This species has, especially during imaginal life, the *Lestes* habit of hanging among aquatic vegetation and dodging among the reed stems to avoid capture.

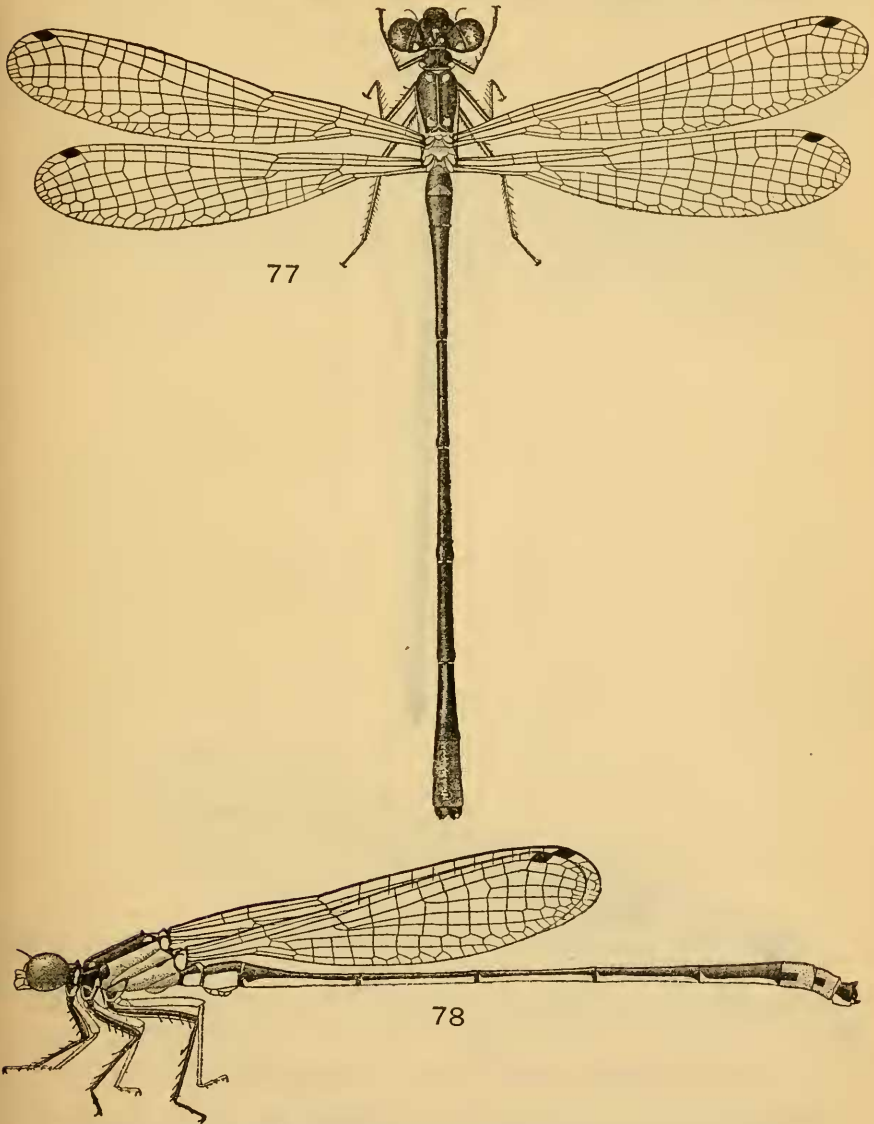
Copulation takes place with the couple moving about among the vegetation or at rest on some leaf, and lasts for many minutes.

In oviposition the female, usually unaccompanied by the male, deposits her eggs in any vegetable substance under the surface of the water which is soft enough to be pierced by her ovipositor, usually the stems of aquatic plants, but sometimes she will alight on the surface of a floating mass of filamentous algae and oviposit in the tangle of algal filaments. Usually the abdomen is bent U-shaped and the wings are loosely folded as in copulation, but occasionally she assumes the poses of *perparva*, with the wings tightly folded. (See figs. 87 and 88.)

I have three pairs which were killed while in copulation. In one, the hold of the male on the prothorax of the female is still retained. Figure 89 shows how the parts fit together. The concave apical edges of the inferior appendages of the male rest on the anterior surface of the posterior lobe, each at about the base of the pencil of hairs. The inferior apical points of the superior appendages rest under the roof-shaped posterior lobe, while the angle of the superiors rests on the mesostigmal lamina. Probably in life the V-shaped prolongation of the dorsum of segment 10 rests on the mesothoracic carina of the female. In this dried pair it is slightly raised.

In copulation, segments 8 and 9 of the female are opposed to segment 2 of the male. The very heavy penis seems to be the sole clasping organ, as the "anterior hamules" fold inward during copu-

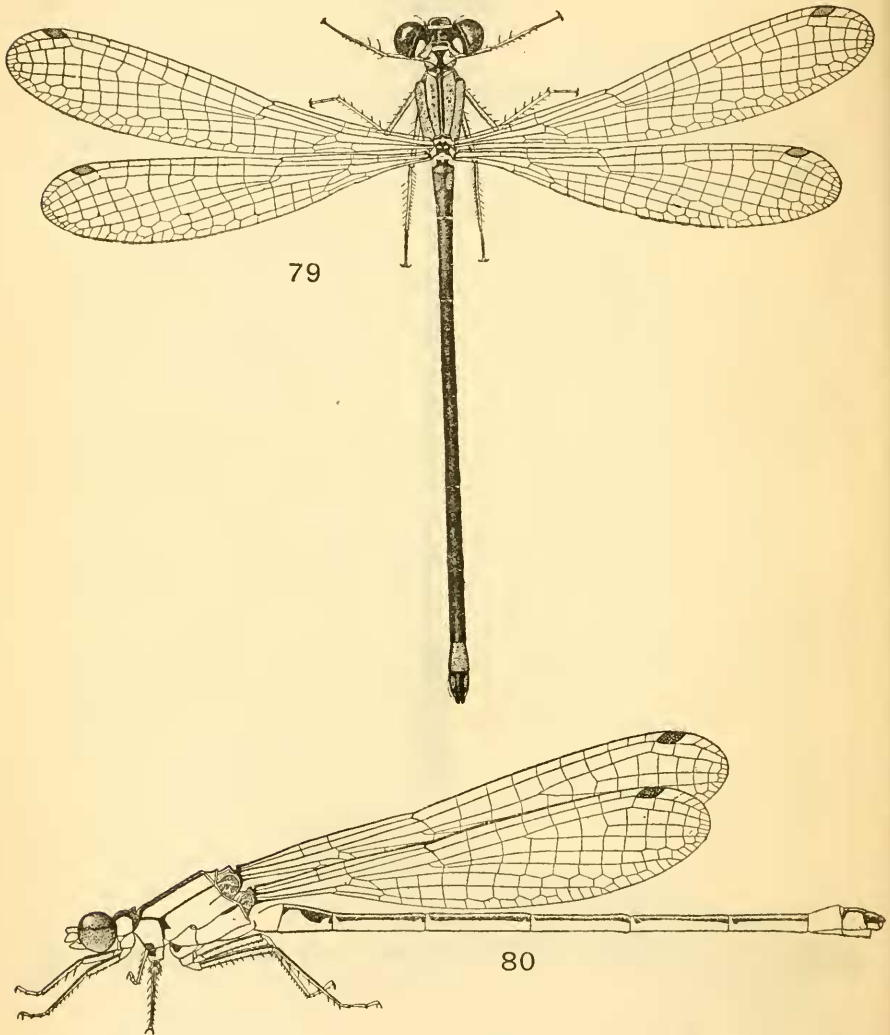
lation (figs. 90 and 91), when the penis is exerted. Among my material I found a single male with the penis exerted and the "anterior hamules" and lamina folded in, but considered it deformed or



FIGS. 77-78.—*ISCHNURA CERVULA*, MALE. 77. DORSAL VIEW. 78. LATERAL VIEW.

injured until I examined the copulated pairs, when I recognized its true meaning. In none of the three dried pairs does the ovipositor sheath of the female fit into the depression of segment 2 of the male, which is made by the infolding of the anterior lamina and its attendant

“anterior hamules.” These “anterior hamules” then function not as claspers but as a sheath for the penis. The distal joint of the penis is bifurcate, the two rami being slender and twice as long as the undivided base of the joint. (Figs. 94 and 95.)

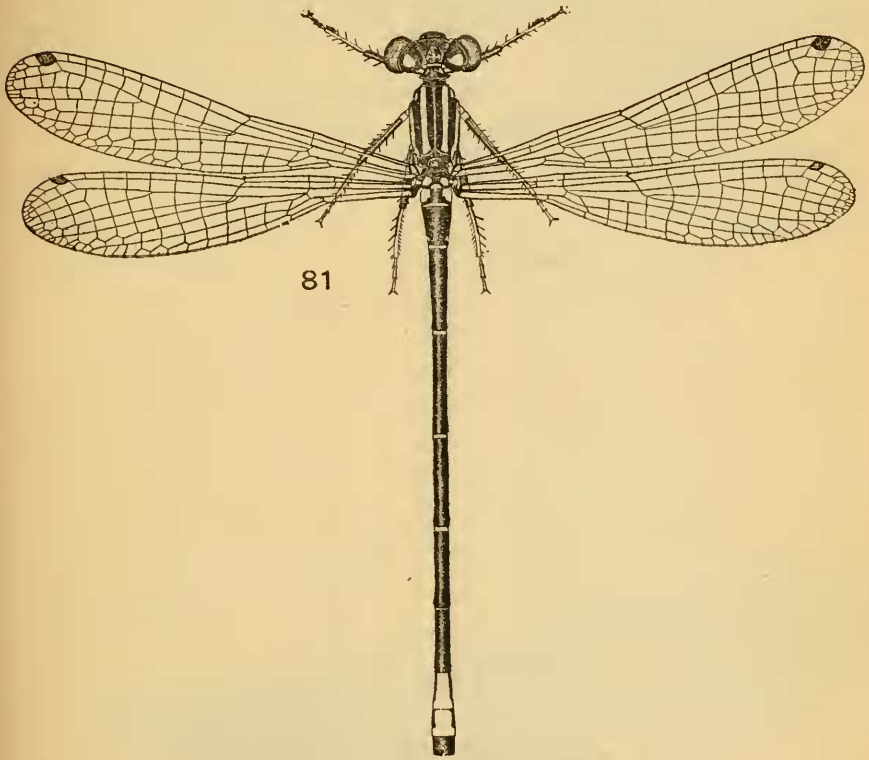


FIGS. 79-80.—*ISCHNURA CERVULA*, FEMALE. 79. DORSAL VIEW. 80. LATERAL VIEW.

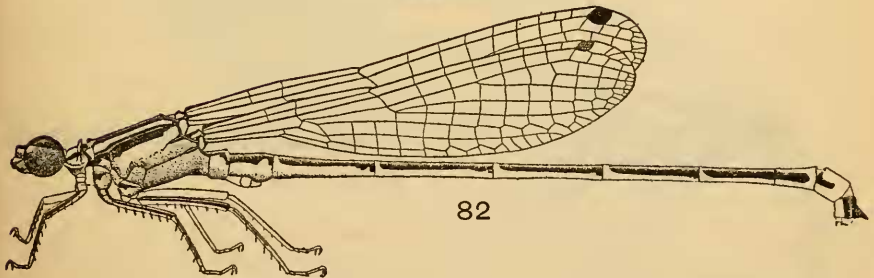
Male (figs. 77, 78, 94-98, 109).—Labrum blue, with a horizontal black line above. Frons blue on the vertical surface, black on the horizontal surface. Vertex with blue band across front, small blue postocular spots, otherwise black, which is continuous with black of the upper part of the eyes. Antennae black. Upper fourth of eyes black, which is abruptly set off by a straight line from the pale

bluish green of the middle eye, which shades gradually into lemon yellow below.

Prothorax black, except a narrow bluish vertical stripe on each side which runs down onto the greenish coxa. Legs black, except a narrow greenish stripe on inner surface.



81



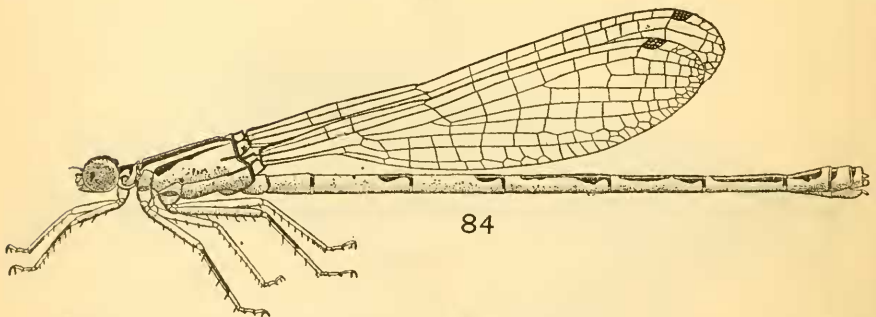
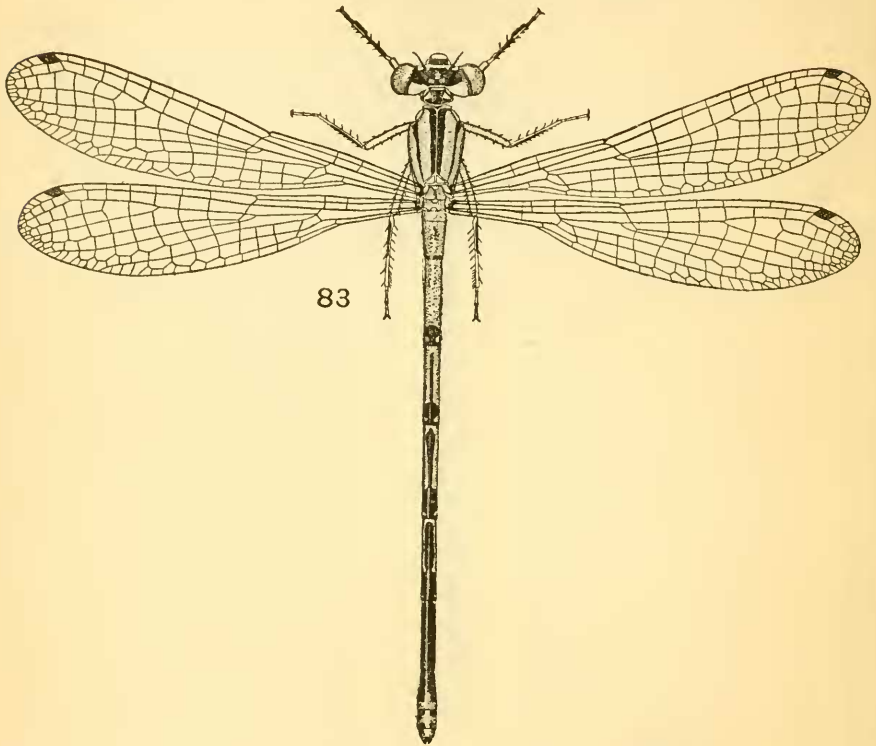
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FIGS. 81-82.—*ISCHNURA PERPARVA*, MALE. 81. DORSAL VIEW. 82. LATERAL VIEW.

Mesothorax and metathorax pale pure blue on sides, shading into greenish on the ventral surface. Mesepisterna and mesinfraepisterna black except an upper and lower blue spot on each mesepisternum. Second lateral suture black. Coxae with an outer ante-

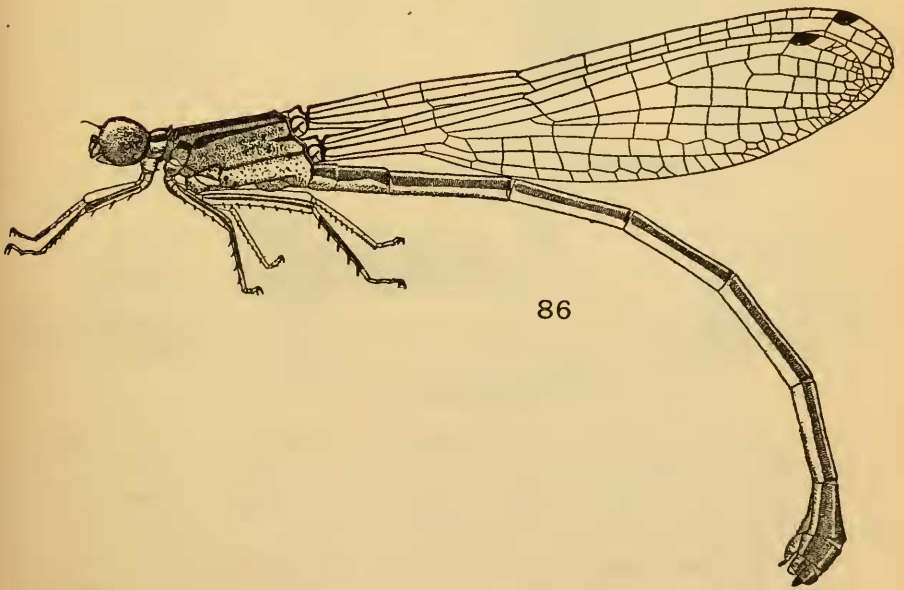
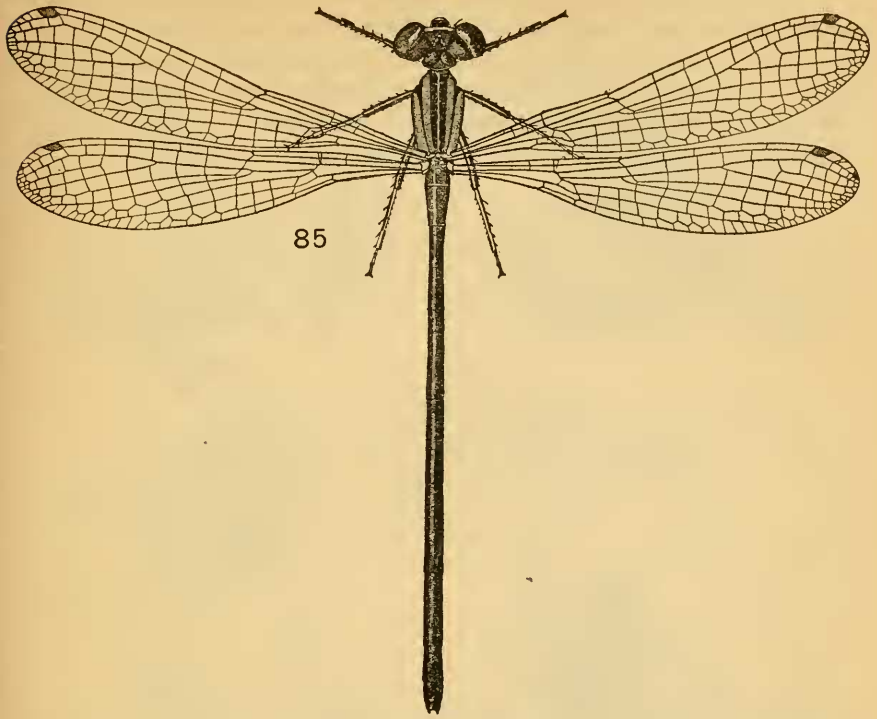
rior black spot. Legs colored as in first pair. Pterostigmas of equal size and black on both front and hind wings.

Abdominal segment 1 bluish green on sides, black on dorsal surface, except a semicircular pure blue spot on apical end of dorsum;



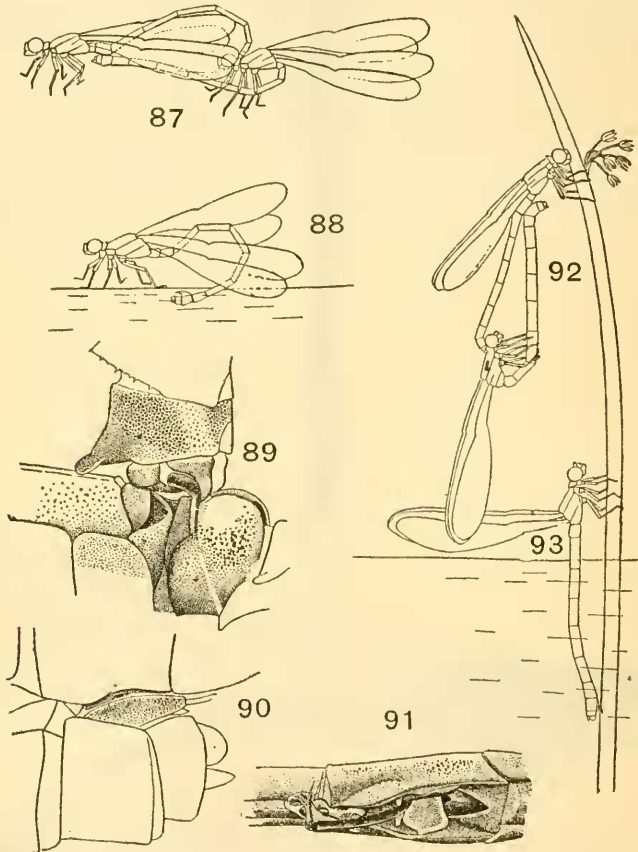
FIGS. 83-84.—*ISCHNURA PERPARVA*, TENERAL FEMALE. 83. DORSAL VIEW. 84. LATERAL VIEW.

segment 2 black above, bluish green below; segments 3-7 black above, yellow below, except an interrupted narrow basal band on segments 4-7; segments 8 and 9 pure blue, each with a rectangular black spot at the anterior end of each side; segment 10 black above, blue below.



FIGS. 85-86.—*ISCHNURA PERPARVA*, AGED FEMALE. 85. DORSAL VIEW. 86. LATERAL VIEW.

In the teneral *cervula*, male, the general color immediately after emergence is pale gray with flesh tints. This is overlaid with the black color pattern. Within an hour or so segments 9 and 10 turn blue, the remaining general color being assumed more slowly. These changes are very simple compared with the series of changes through which the coloration of the *cervula* female goes.



FIGS. 87-91.—*ISCHNURA CERVULA*. 87. IN COPULATION. 88. OVIPOSITING. 89. MALE CLASPING ORGANS ATTACHED TO FEMALE PROTHORAX. 90. COPULATION, DETAIL. 91. MALE, SEGMENT 2, PARTS IN COPULATORY POSITION.

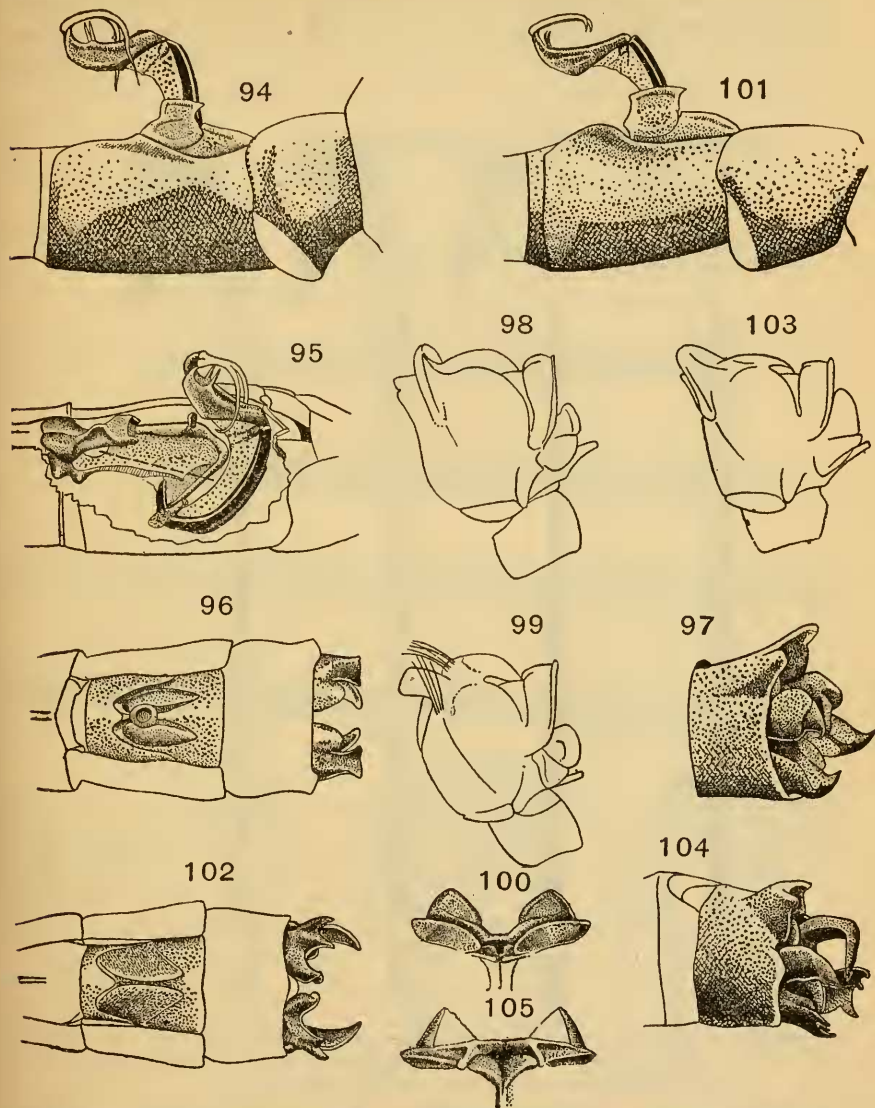
FIGS. 92-93.—*ISCHNURA PERPARVA*. 92. IN COPULATION. 93. OVIPOSITING.

The following are the various colorations found among the females (figs. 79, 80, 106-108, 117-119):

1. *Female*.—Teneral colors mostly a light shade of brown with black markings. (See figs. 106 and 117.)

Labrum gray, shading into brown above, edged above by a horizontal black line. Frons gray on vertical surface, black on horizontal surface. Vertex black, but with a broad transverse band of gray in front connecting the gray genae. Postocular spots large, brown, and

connected by a brown line. Antennae black. Eyes light gray, with darker spots. Under surfaces of head pale gray, almost white.



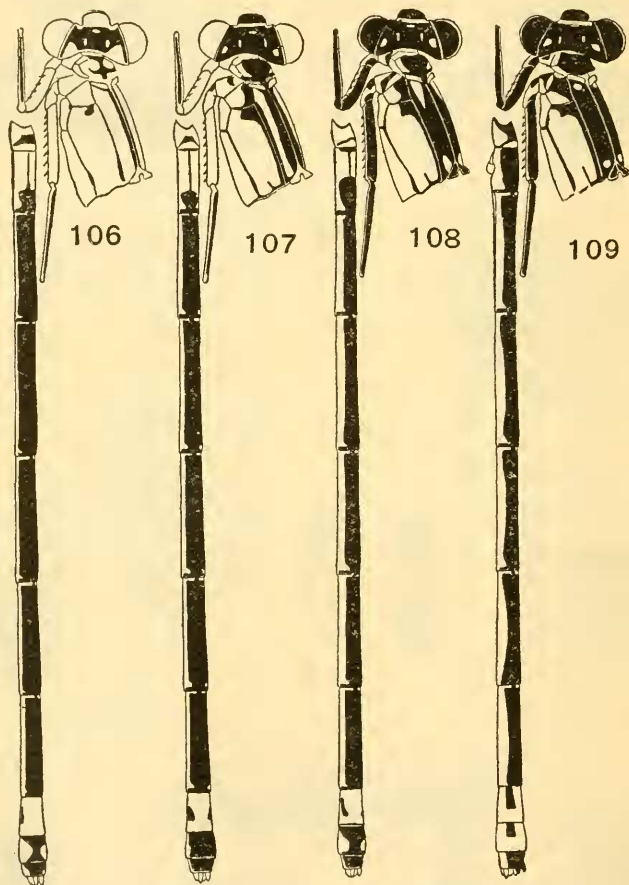
FIGS. 94-100.—*ISCHNURA CERVELLA*. 94. MALE, SEGMENT 2. 95. MALE, SEGMENT 2 DISSECTED. 96. MALE, SEGMENTS 9 AND 10, VENTRAL VIEW. 97. MALE APPENDAGES. 98. MALE PROTHORAX. 99. FEMALE PROTHORAX. 100. FEMALE MESOSTIGMAL LAMINA.

FIGS. 101-105.—*ISCHNURA PERPARVA*. 101. MALE, SEGMENT 2. 102. MALE, SEGMENTS 9 AND 10, VENTRAL VIEW. 103. MALE PROTHORAX. 104. MALE APPENDAGES. 105. FEMALE MESOSTIGMAL LAMINA.

Prothorax brown, marked with black as follows: A narrow transverse line at base of anterior lobe. This widens on the middorsal line into a triangle, the apex of which extends caudad to the anterior

angle of a diamond marking at the base of the posterior lobe. Legs pale brown except narrow black stripe on outer surface of tibiae.

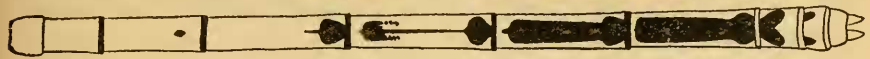
Mesothorax and metathorax pale brown, except as follows: Broad middorsal stripe (in some individuals a mere line); a spot on the anterior end of mesepimeron; dorsal end of both humeral and second lateral sutures narrowly black. Legs as in prothorax.



FIGS. 106-109.—*ISCHNURA CERVULA*. 106. TENERAL FEMALE WITH LIGHT COLORATION. 107. TENERAL FEMALE WITH DARK COLORATION. 108. FEMALE WITH VERY DARK COLORATION WHICH APPROACHES MALE COLORATION. 109. MALE COLORATION.

Abdomen pale brown, except as follows: Segment 2 with a diamond-shaped, or in some individuals a spade-shaped spot on posterior end of dorsal surface; segments 3 to 7 each with dorsal surface black, except for a narrow pale interrupted band across the anterior end; segment 8 pale blue, usually with small lateral mark; segments 9 and 10 with dorsal surface black, the black extending down in a narrow stripe on either side of the anterior end.

2. *Female*.—Some teneral females (figs. 107 and 118) are more heavily marked than the previous description would indicate, but the form



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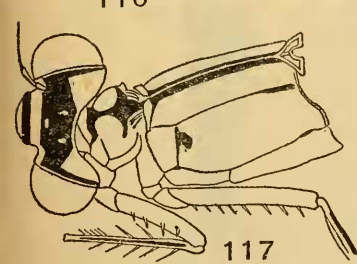
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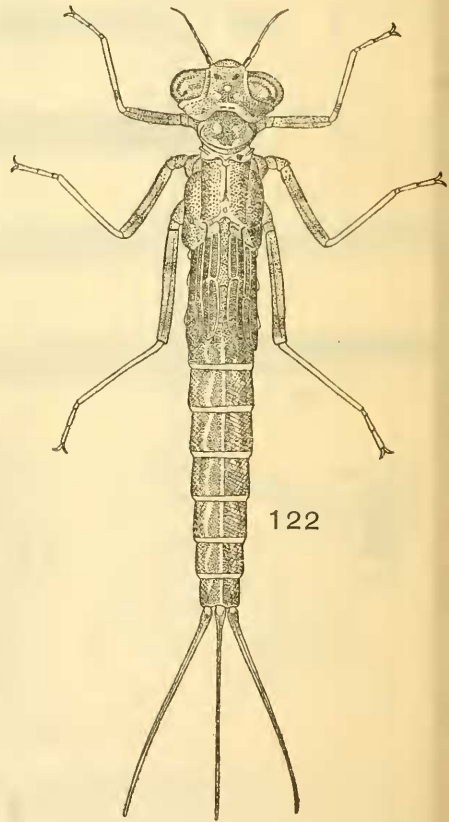
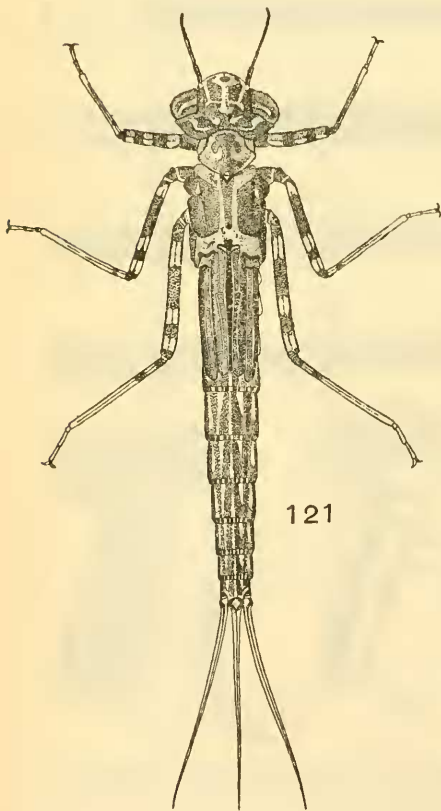
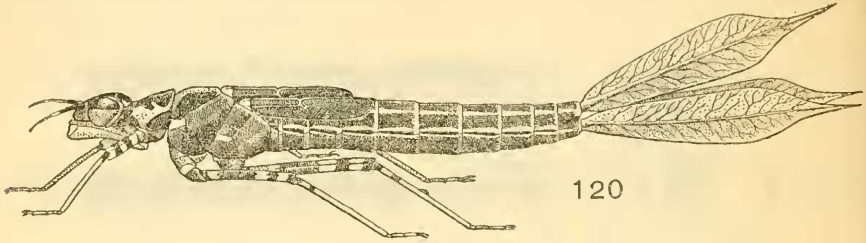
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FIGS. 110-116.—*ISCHNURA PERPARVA*, FEMALE. 110-114. VARIATIONS IN TENERAL COLORATION. 115. STAGE INTERMEDIATE BETWEEN TENERAL AND ADULT, SHOWING FORMATION OF ADULT COLORATION ON SEGMENTS 1-4. 116. ADULT COLORATION.

FIGS. 117-119.—*ISCHNURA CERVULA*, FEMALE. 117. TENERAL FEMALE WITH LIGHT COLORATION, SAME AS FIG. 106. 118. TENERAL FEMALE WITH DARK COLORATION SHOWING FORMATION OF ADULT COLORATION ON EYES AND FEMORA, SAME AS FIG. 107 BUT OLDER. 119. FEMALE, FINAL OR SENILE COLORATION.

intergrades with the first. In this form the postocular spots are very much reduced and have no connecting bar. The entire dorsal surface of the prothorax is black. The coxae have an anterior black spot.

Upper half of mesinfraepisternum black. Middorsal stripe broad. Humeral stripe broad and widening below into a large rectangular spot on anterior end of mesepimeron. Second lateral suture with a narrow black line. Femora brown as in the lighter individuals.

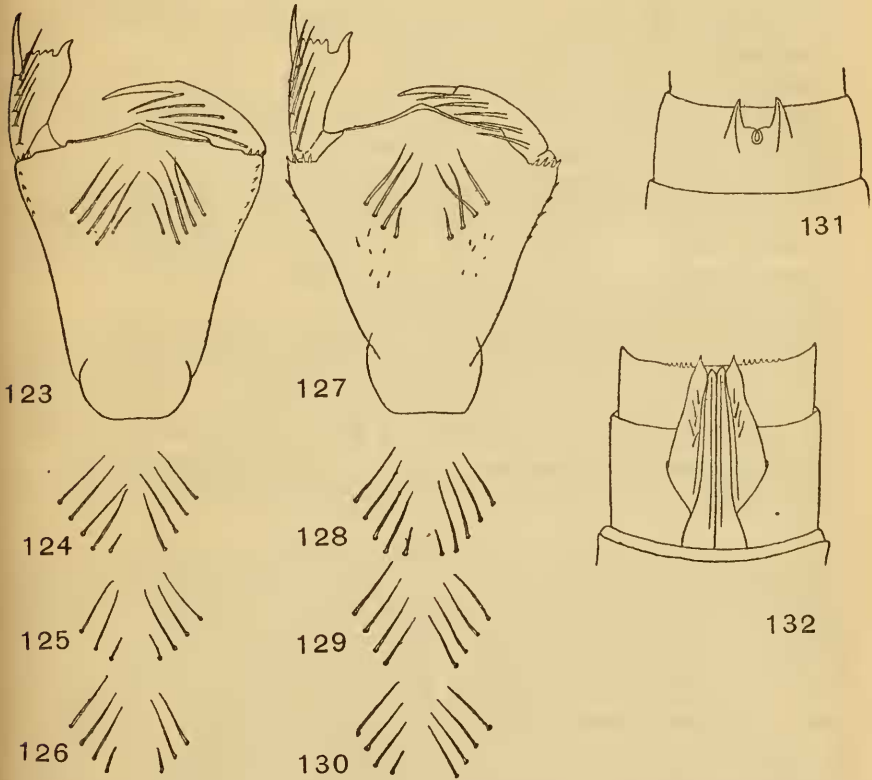


FIGS. 120-121.—*ISCHNURA CERVULA*, NYMPH.

FIG. 122.—*ISCHNURA PERPARVA*, NYMPH.

Abdomen same as in the lighter colored females except that the dorsum of segments 9 and 10 may be black. (Fig. 107.) Figure 118 shows one of these females in a late teneral stage, when eyes and femora are turning black.

3. *Female*.—Adult coloration: Labrum greenish, frons blue on vertical surface, black on horizontal surface. Vertex black, including upper one-fourth of eyes, which is sharply demarked from the lower greenish three-fourths by a horizontal line, except a pale pure blue band across front of vertex from eye to eye and the usually connected pale blue postocular spots.



FIGS. 123-126.—*ISCHNURA PERPARVA*, NYMPH. 123. DORSAL VIEW OF LABIUM. 124-126. MENTAL SETA OF THREE REARED NYMPHS.

FIGS. 127-132.—*ISCHNURA CERVULA*, NYMPH. 127. DORSAL VIEW OF LABIUM. 128-130. MENTAL SETA OF THREE REARED NYMPHS. 131. MALE SEGMENT 9, VENTRAL VIEW. 132. FEMALE SEGMENT 9, VENTRAL VIEW.

Thorax pale blue, but markings may be either as in description No. 1 or No. 2. Coxae and femora vivid rose pink. Femora and tibiae with an outside black stripe. Pterostigmas pale brown.

Abdomen marked as in teneral, but segments 1 and 2 blue, segments 3 to 8 greenish yellow, and segments 9 and 10 pure blue.

4. *Female*.—Final or senile coloration (fig. 119): Labrum olive. Vertical surface of frons olive, horizontal surface black. Entire dorsal surface of head black, including the sharply defined dorsal one-fourth of the eyes. Lower three-fourths of eyes green, shading into yellow below.

Prothorax black on dorsal surface, shading into olive on sides and coxae. Legs black, with bluish olive stripe on lower surface.

Mesothorax and metathorax black on dorsal surfaces, shading into olive on lower sides. Legs as in first pair.

Abdomen with dorsal surface black, shading below into olive on segments 1 and 2, into yellow on segments 3 to 7, and into olive on segments 8 to 10.

5. *Female*.—Melanistic. I have a single melanistic female (fig. 108), which approaches the male coloration.¹

Labrum gray, with black line above. Frons blue on vertical and black on horizontal surface. Vertex black, except small round disconnected postocular spots and the blue stripe from eye to eye along its anterior edge. Eyes black on upper one-fourth, green below.

Prothorax with black band across anterior lobe. Middle lobe black on dorsal surface. Posterior lobe black, except a large blue triangle on each outer angle. Coxae blue, with black anterior spot. Legs black, with bluish stripe on inner surface.

Mesothorax and metathorax with sides and lower surface blue, with very broad middorsal and humeral stripes which fuse along the middle two-fourths of their length, leaving a pair of oval blue spots near the antealear sinus, and below, a pair of lanceolate blue spots next the mesostigmal laminae. Legs as in the prothoracic legs.

The abdomen has the distinctive female coloration described in No. 1.

The "adult coloration," No. 3 of *cervula* females, is a stage which is rather transitory, as the delicate blues, pink, and yellow become early obscured by black, which in the very old females may become slightly pruinose. The females, which I reared, emerged into coloration No. 1 or No. 2, and died while still in that color, but in the field I have taken very fresh appearing females of coloration No. 3. Because of the difficulty always found in arranging a large series of fresh females in a series according to the age of their coloration, I have wondered if coloration No. 3 could also be a teneral and representing a second form of coloration. All the aged females are black, No. 4. As this species frequently emerges in swarms the tenerals are at times very numerous. However, the coloration which is ordinarily found is black (No. 4). At any time in May or June, when this species is most abundant, individuals in every stage of coloration can be taken.

Within a few hours after death the delicate pink, blue, and yellow fade, leaving the dried specimens gray or pale brownish.

¹ Since writing this I collected a second female of this coloration in the Sacramento Valley of California and several others at Palo Alto. In these the 4 thoracic blue spots are similar to those of the male.

As in females of *perparva*, the late or adult black pattern is superimposed on the black pattern of the teneral and is not a development from the first black pattern. This is especially noticeable in the thorax, where the dorsal and humeral stripes remain sharply defined, though only faintly visible until the intervening blue mesepisternal stripes become almost black.

The nymphs of both *cervula* and *perparva* are to be found in large numbers in the trash among cattails in the "tule" swamps south of Sunnyside. While a rake brings out both species, the nymphs of *perparva* are usually covered with mud, while *cervula* nymphs are clean, though one species is about as hairy as the other. This fact, in connection with that of the shorter legs of the *perparva* nymphs, suggests that the *perparva* nymphs are more mud-loving and that the *cervula* nymphs prefer the trash and aquatic vegetation above the slimy bottom.

The descriptions of the nymphs of *cervula* and *perparva* are based on 10 *cervula* and 12 *perparva* nymphs which were reared at Sunnyside during June and July, 1913. It is easy to notice certain differences in color and length of legs between the two series of exuviae, when laid in two rows for comparison, but the differences are so slight and so easily confused by other varying conditions that I can not certainly separate from a mixed series any but the most brightly colored *cervula* larvae. *Perparva* nymphs may be pale brown, black, or bright green, probably depending on food and nearness to molt. Usually *cervula* nymphs are easily distinguished by their brilliant black color pattern, especially the vivid banding on the legs. In some reared specimens, however, the exuviae are almost without color, although even in these the bands of the legs, though pale, are sharply defined.

Nymph (figs. 120, 121, 127-132).—Length, 11-12 mm., gills, 6 extra; abdomen, 8; hind femur, 3.

Color usually black because of the heavy color pattern, though it may be very light. Among the exuviae are 7 males, which vary from almost colorless to very black.

Head with the distance between antennae relatively wide, in measured specimens being five-sixteenths of width of head. This extra width is correlated with a greater width of the anterior edge of the submentum than is found in *perparva*. The mentum is usually slightly shorter than in *perparva*, thus accentuating the slightly greater width. However, perhaps from warping, the mental proportions in exuviae are not constant. Mental setae usually four in each row—in one specimen five in each row. Each lateral lobe with five raptorial setae, a large movable hook, and five end teeth the inner one of which is large and set off from the row of four small ones by a deep notch.

Thorax relatively large; wing pads held parallel and reaching to the middle of the fourth abdominal segment. Legs long and sprawling. Abdomen conical, slender; the gills large, increasing in width to the apical third, then rapidly reduced to an attenuate apex.

The color pattern is complex, usually vivid, and is as follows: Head black, with white area over location of adult median ocellus, from which a stripe runs forward and a branch on either side runs laterad of its eye and antenna. Postocular spots comma-shaped. Eyes gray. Prothorax white, with a black *fleur-de-lis* design. Coxae and trochanters black, femora with two black bands and the distal end black. Mesothorax and metathorax black, with middorsal pale areas and the dorsal edges of the episterna light. A light spot on the dorsal half of each infraepisternum. Legs banded as in the first pair. Abdomen black, with a row of spots along the lateral keels, a middorsal stripe, and a row of spots on each side midway between the lateral keels and the middorsal stripe. Gills plain.

This nymph differs from that of *perparva* in the longer legs, the greater distance between the eyes, and the sharp banding of the legs.

ISCHNURA PERPARVA Selys.

Figs. 81-86, 92, 93, 101-105, 110-116, 122-126.

Ishnura perparva occurs during the entire odonate season and is frequently as abundant along the stagnant side pools of fresh streams as it ever is about alkaline ponds, where it occurs in equal abundance with *cervula*. In other words, it seems to be adapted to a wider variety of conditions than *cervula*.

In habits it resembles *cervula* but, when at rest in copulation (fig. 92), or ovipositing (fig. 93), the wings are usually held tightly closed. Being a heavier bodied insect, the abdomen is seldom bent into the U-shapes common with ovipositing *cervula*. As in *cervula* the males rarely accompany the females while the latter are ovipositing.

Male (figs. 81, 82, 101-104).—Labrum greenish, with black line above. Frons greenish in front, black on horizontal surface. Entire top of head black, except broad greenish band across front and small greenish postocular spots. Antennae black. Eyes abruptly black above, pale green below.

Prothorax black above, except narrow greenish line along base of anterior lobe and a small greenish spot on either side of the middle lobe. Sides of prothorax, coxae, and legs yellowish green, with femora broadly black on outer surface and a narrow stripe on outer face of tibiae.

Mesothorax and metathorax pale green, with broad middorsal stripe and broad humeral stripes. Legs colored as in first pair.

Pterostigma of fore wings black, of hind wings dusky, those of hind wings much smaller.

Abdominal segment 1 pale green, with triangular black spot and a black apical line extending down either side; segment 2 greenish with dorsum broadly black and a black apical line as in segment 1; segments 3-7 black above, lemon yellow on sides and ventral surface; segments 8 and 9 pale blue, with a rectangular black spot on either side; segment 10 with dorsal half black and ventral half yellow.

In the teneral male the colors on emergence are steel gray with the above described markings.

Female (figs. 83-86, 105, 110-116).—The females of *perparva* do not possess two color forms in the mature imago. The mature colors are an obscure smoky green with black markings, which is usually very heavily overlaid with a gray pruinose.

The teneral colors (figs. 83, 84, 110-114) are orange and black, and in detail are as follows:

Labrum pale greenish orange, with a minute black triangle on its dorsal edge. Frons orange on its vertical surface and black on the horizontal surface. Vertex orange between the antennae, the remainder black, except large connected orange postocular spots. Eyes dark green above, pale below. Antennae black. Under parts of head pale yellowish.

Prothorax orange, paler on lateral and ventral surfaces. Anterior lobe with anterior edge black; middle lobe black, with a small orange area on each side; posterior lobe orange. Coxae, trochanters, and femora pale orange and without markings. Tibiae yellow, with a narrow black stripe on outer side. Tarsi green.

Mesothorax and metathorax orange, paler below, with a broad black dorsal stripe. On either side a black humeral stripe, narrower across the dorsal edge of the mesinfraepisternum. Legs colored as are first pair. Wings colorless, pterostigmas clear, yellowish.

Abdomen orange, marked with black as follows: Segment 1 with two minute spots on dorsal surface; segment 2 with minute cross line on dorsal surface and a narrow apical ring; segment 3 with a spade-shaped marking on apical one-fourth of dorsal surface, and an apical ring; segments 4 to 7 with dorsal surface black, except narrow basal ring, and on segment 7 a narrow apical ring; segment 8 with a large U spot, the U opening caudad; segment 9 with small anterior spot on either side; segment 10 orange.

The teneral on emerging is a pale flesh color with the dark markings just described indicated by gray. Within an hour or two the orange and black coloration has been assumed. Figure 114 shows the usual color pattern on the abdomen of a teneral female *perparva*. Figures 110 to 113 are less common forms. Figure 115 shows a female colored

as in figure 111, which is passing from the teneral color pattern to the adult pattern shown in figure 116, by the darkening of the orange areas shown in the figure by stippling. As mentioned for *cervula* females, the adult black pattern is superimposed onto the teneral black pattern by certain of the orange areas becoming brownish, then smoky, and finally black.

The following black markings appear on the mature female (see figs. 85, 86, 116):

All of the dorsal surface of head black, except pale band above frons. Entire dorsum of prothorax black. Dorsum of all abdominal segments black, except a narrow pale apical cross line on segments 1, 7, 8, and 9. Pterostigmas smoky. The entire body and legs are more or less pruinose, making a slate gray insect. The paler colors of the sides of the thorax and legs and sides of the abdomen, which are obscured by this pruinosity, are olive green. In very old females the only light color remaining is a brownish stripe on the outer edge of the mesepisternum. In dried material the blue element in the olive green fades, leaving the insect brownish or orange with pruinose and black markings. In both species the blue element, either pure and by itself or in a mixed color like green, is very likely to fade easily in dried material, leaving the more permanent yellow element. This is probably where the frequent dimorphism of the female *Ischnuras* comes in. The males are seldom pure blue, but greenish—a combination with a yellow and a blue element. In the yellow dimorphs the blue element is lacking. However, in *perparva* the orange female is merely the teneral.

The mature pruinose females of this species are very common, the males less common, the orange teneral less common yet, and the intermediate forms between the orange teneral and the adult pruinose female are rare. Among 250 specimens I have 40 orange tenerals and only 5 intermediate between the teneral and the pruinose. I have inferred that the orange teneral condition lasts the first day, the change to adult occurring during the first night of imaginal life. But this is merely a guess to account for the rarity of the intermediate forms.¹

Nymph (figs. 122–126).—The nymph of *perparva* has been described by Needham. The following points may serve to separate it from that of *cervula* and other species: Length, 11–11.5 mm., gills, 5 extra; abdomen, 7–7.5; hind femur, 2.5; width between eyes four-sixteenths of total width of head. This nymph is similar to that of *cervula* but differs in the shorter legs, the narrower space between the eyes, and the obscure color pattern. In life, because of the muscles and other internal organs showing through, the *perparva*

¹ I have just succeeded in rearing and keeping a teneral female alive four days without change of the orange color. The change in color may be due to fertilization.

nymphs are easily confused with the more lightly pigmented *cervula* nymphs. However, in the exuviae, while the legs frequently show indistinct bands, the edges of these fade out, giving a lack of sharp definition as occurs in *cervula*, even in the pale *cervula* exuviae. As shown by the figures 124-126, the labial setae are not a reliable diagnostic character.

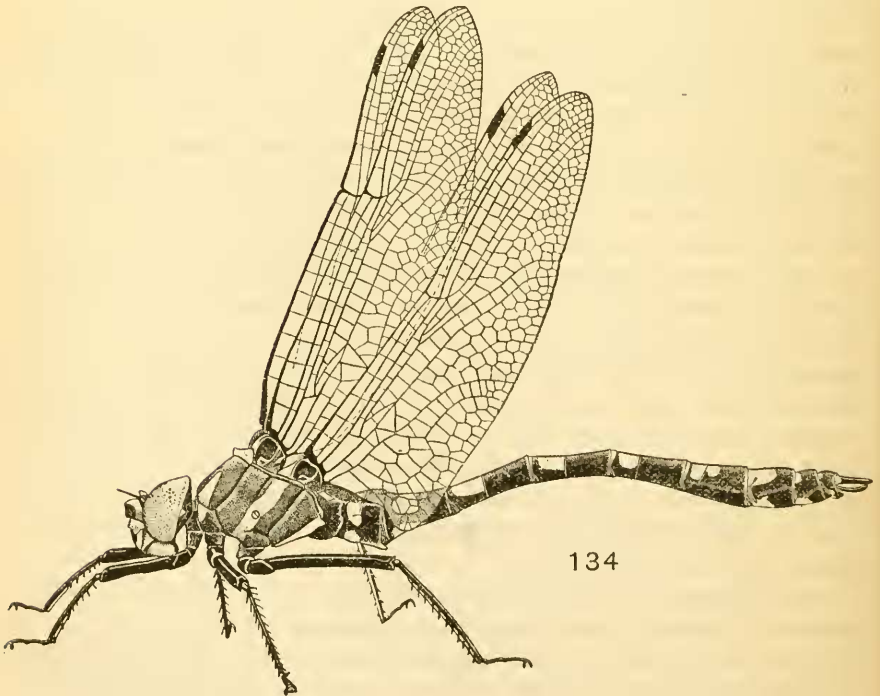
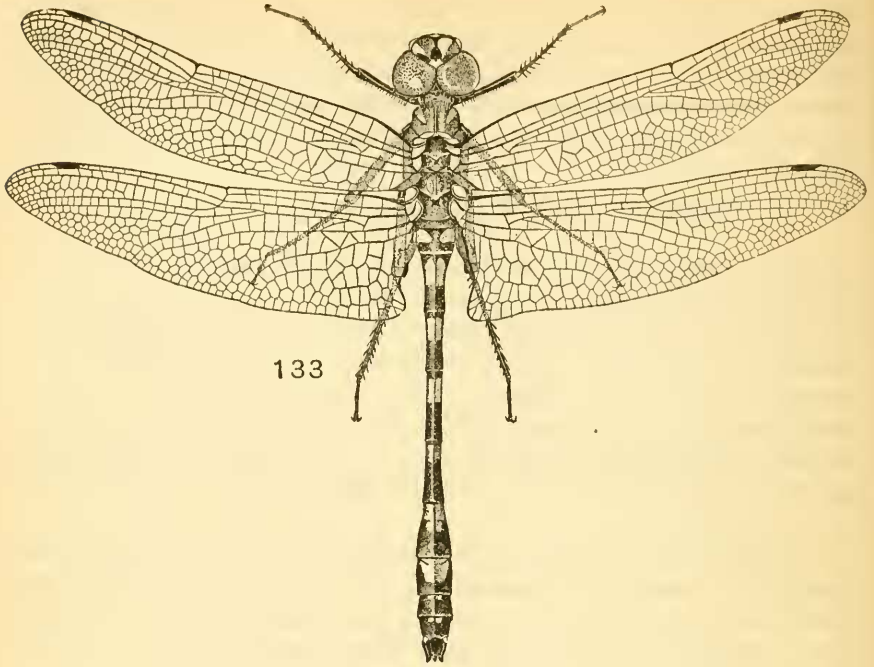
4. NOTES ON MACROMIA MAGNIFICA AND ITS NYMPH.

While collecting on Satus Creek, Yakima County, Washington, July 27, 1913, I became suspicious of my determination of certain very swift dragonflies which I had been unable to net, but which I had hitherto thought were *Aeshna multicolor*. To satisfy myself I returned August 3 with a shotgun, a few shots from which showed these swift fliers to be *Macromias*, which on later examination proved to be *Macromia magnifica* (figs. 133-145). After using 25 shells loaded with No. 10 shot I hit nine *Macromias*, five of which were still usable as specimens.

On August 7 I returned with Professor Farr, of Sunnyside, and during two days of strenuous effort we netted three *Macromias*. With the use of the gun and a second box of shells we procured three more specimens. On this trip we searched for nymphs and exuviae, but found none.

On August 24 I returned alone and netted a single specimen, the same day finding five exuviae in an alder tree. These were from 2 to 10 feet above the surface of the creek in a tree, under whose roots the creek had cut, forming a pool about 3 feet deep, which was half filled with the fibrous alder roots. One exuvia was fastened with outspread legs close to the trunk of the tree, but the other four nymphs had crawled up and out on limbs and finally onto twigs less than the size of a straw, from which the skins were hanging back downward. As these were found late in the day I did not search further, but returned on September 7. This time in an alder tree similarly situated were found six more exuviae, while in the mass of roots in the pool beneath the tree was found a live nymph of the 1914 brood. A short distance from this in a third alder tree overhanging an undercut bank were found three more exuviae. Probably *Macromias* had emerged from other tree-fringed pools but these three trees were the only ones so situated that they were well enough protected from the wind to prevent the blowing down of the exuviae, as these must have been hanging, when found, not less than six weeks.

As contrasted with the restless activity of the adults the movements of the nymph were extremely deliberate. In fact, he betrayed his presence in the tree roots thrown out onto the bank, not by his movements but by a slight chirping noise made in expelling air from the cloacal chamber.



FIGS. 133-134.—*MACROMIA MAGNIFICA*, MALE. 133, DORSAL VIEW. 134, LATERAL VIEW.

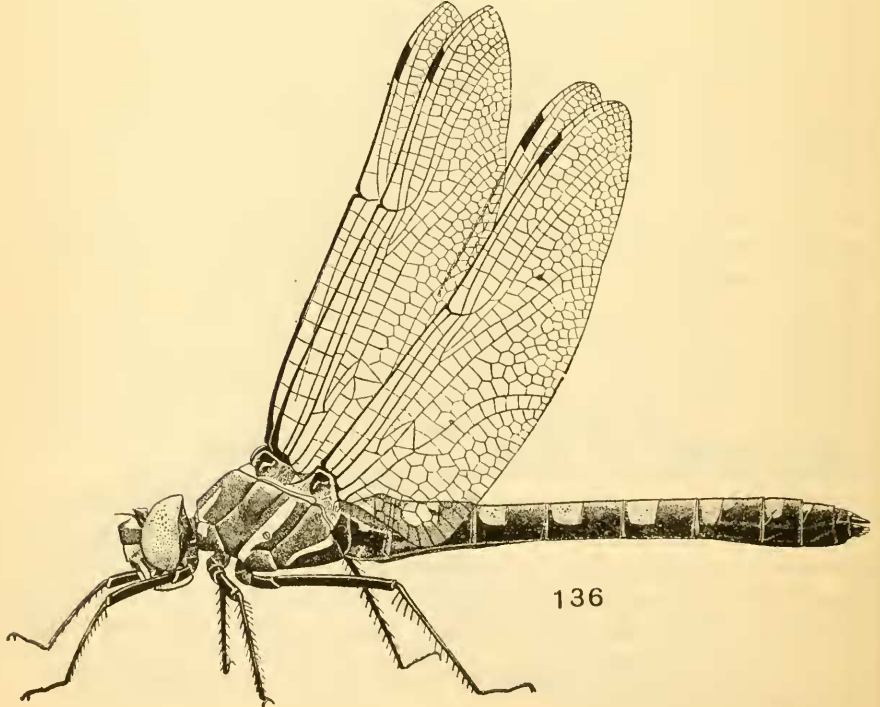
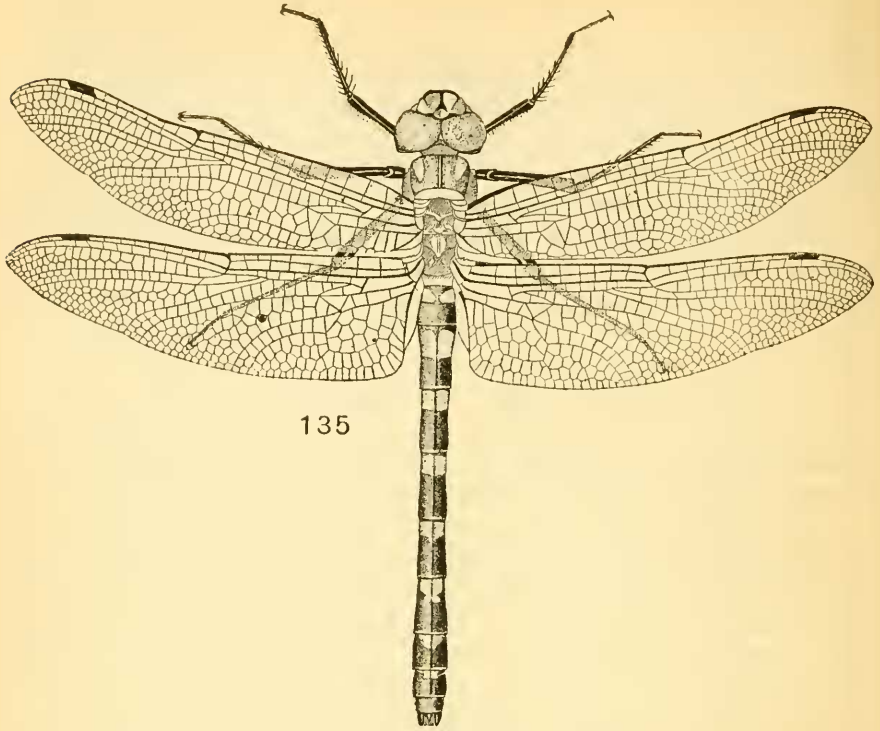
As the numbers of these *Macromias* were at their height on July 27 they probably had been on the wing three weeks, for they rapidly disappeared after August 7, and none were seen after August 24.

A short description of the Satus Creek region is given in my second paper of this series (see pp. 269-270), but the following details may serve to make more clear the habits of this species. Satus Creek, after it emerges from Satus Canyon onto the Yakima River flats, is a cool shallow stream of less than 10 second-feet, which meanders over long gravel riffles from pool to pool. These pools are about 25 feet wide, from 50 to 200 feet long, and, with few exceptions, are not over 4 feet deep. They are gravel bottomed, except under high dirt banks, where there is usually some mud, and are free from aquatic vegetation and brush, thus offering no protection to dragonfly nymphs, except pools overhung by alders, where the alder roots form intricate masses inhabited by lamprey eels, crayfish, and the nymphs of *Agrion aquabile yakima*, *Aeshna umbrosa occidentalis*, and *Macromia*.

The male *Macromias* were usually found patrolling the larger pools or sometimes a patrol would include two or three of the shorter pools. Seldom were more than three or four males seen at any one time, and each male's beat was rarely over 300 feet long. The flight was very swift, ordinarily about 2 feet above the surface of the water and straight down the middle of the pools or, on the broader pools, up one side and down the other. For speed few dragonflies can equal it. The speed was so great that even when I knew the passing dragonfly was a *Macromia*, black with yellow spots, it appeared a uniform gray; hence their confusion on the wing with *Aeshnas*. They were unusually fearless and in the futile attempts to take them many times dodged between the collector and the net. One even flew between my legs. After much aggravation I found that by wading into the deeper parts of a pool and facing a dirt bank not less than 5 feet high so as to leave a passageway of about 4 feet for the patrolling *Macromias*, occasionally one could be netted, for the nearness of the overhanging bank seemed to make them fear to dodge. They were perhaps a little more easily taken when struck at from the rear than when coming head on into the net, for when coming head on and fairly in the net, before the collector could twist it shut they would bounce back and out, apparently rebounding by some trick of the wing on the cushion of dead air in the net.¹

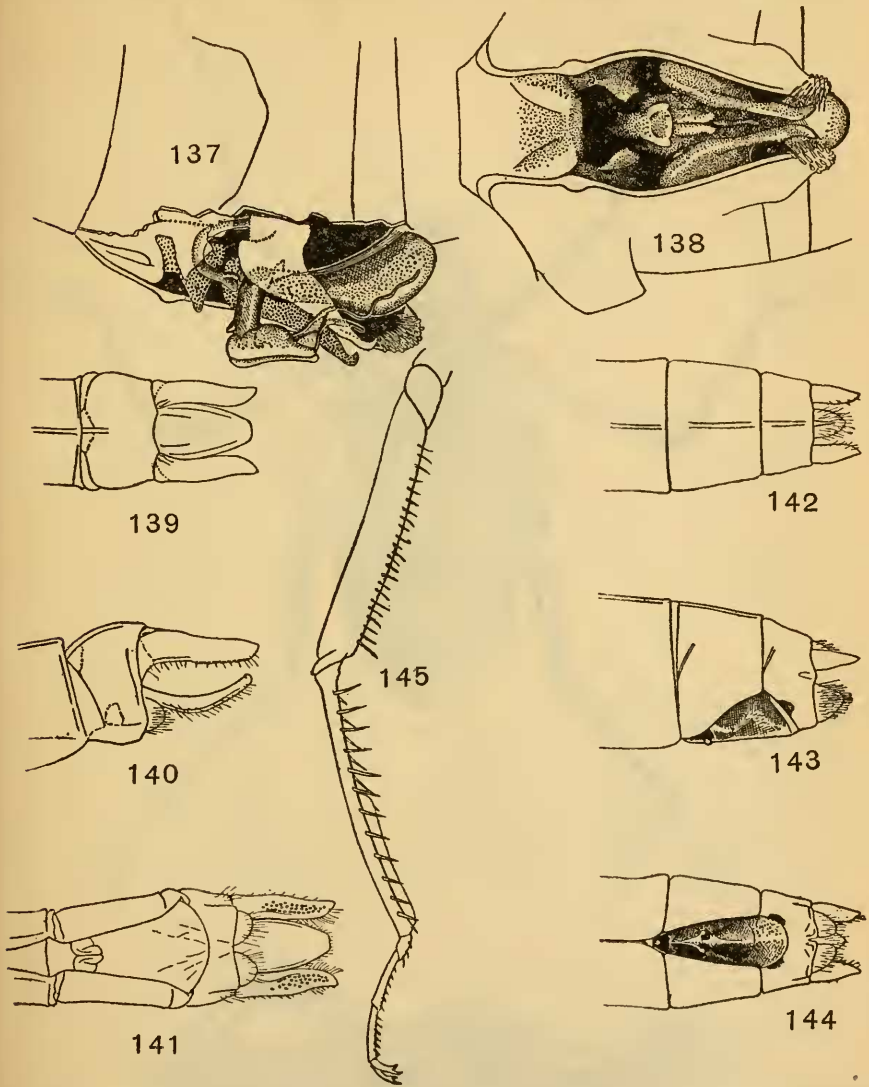
This species was found most commonly over the water on calm days between the morning hours of 7 and 10. Few were found in the afternoons or on windy days. The flight over the water appeared to be controlled by the ovipositing females, who resorted to the water to oviposit early in the day in calm weather, where they were sought

¹I have since found this species common on the larger warmer streams of California and Nevada and in some places rather easily captured.



FIGS. 135-136.—*MACROMIA MAGNIFICA*, FEMALE. 135. DORSAL VIEW. 136. LATERAL VIEW.

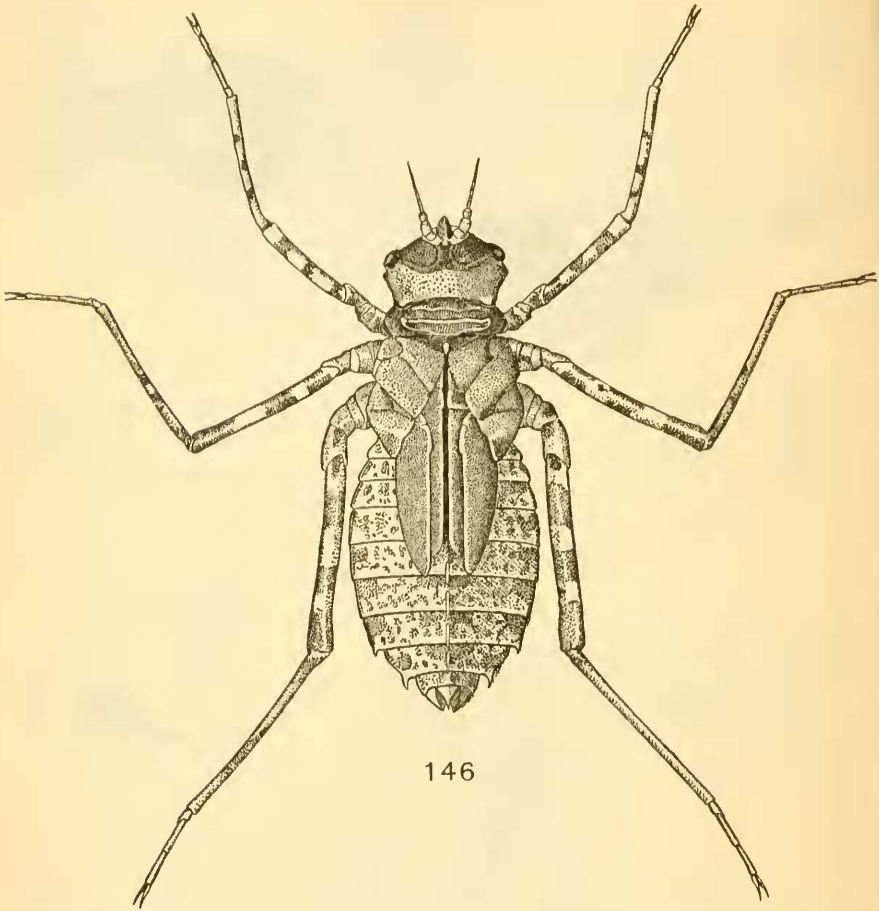
by the males. As the females oviposited by striking the end of the abdomen on the surface of the largest pools only, this could not be



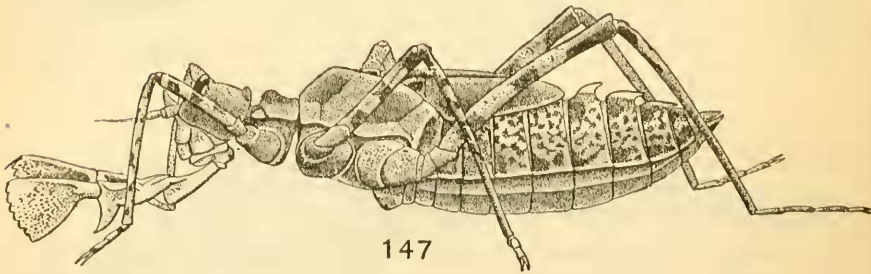
FIGS. 137-145.—*MACROMIA MAGNIFICA*. 137-138. SEGMENT 2 OF MALE. 139-141. SEGMENT 10 AND APPENDAGES OF MALE. 142-144. SEGMENTS 9 AND 10 OF FEMALE. 145. FRONT LEG OF MALE SHOWING TIBIAL KEEL.

done except when the surface was smooth. At other times even until late twilight individuals of both sexes might be found patrolling glades and barnyards as much as a half mile from water. Here the

flight varied from close over the ground to as high as the trees. One pair was seen in copulation at noon a half mile from the creek.



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FIGS. 146-147.—*MACROMIA MAGNIFICA*, NYMPH. 146, DORSAL VIEW. 147, LATERAL VIEW WITH LABIUM EXTENDED.

On only two of the days spent in collecting was the weather calm enough to permit free oviposition. On these days there were three or

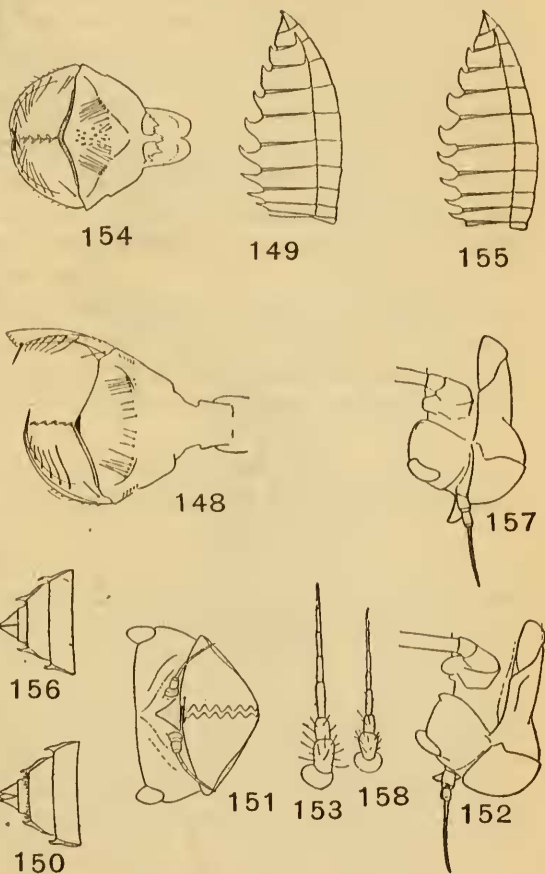
four males to each female. In ovipositing the female would fly several times back and forth over a short beat of 40 or 50 feet, striking her abdomen on the surface of the water at 3 to 5 foot intervals. This beating back and forth generally lasted until a male discovered her, when she would be taken away in copulation. At such times the male swooped and grasped the female's head with his feet, then bending the abdomen forward and grasping the female's head with the abdominal appendages he would free his feet and she would bend her abdomen forward and copulate. (See fig. 159.) The copulatory flight was ordinarily away from water over the surrounding trees, but ended in a long period of copulation while resting on some bush or tree. One pair, observed resting in copulation for 15 minutes, on being disturbed flew away still in copulation.

In form and coloration the specimens collected on Satus Creek

(see figs. 133-136) agree with the description in Mr. Williamson's review of the genus, except that the length of the abdomen in the males varies

from 51 to 53 millimeters. In life the eyes are pale gray, the thorax a deep brown overlaid with pruinose.

The nymph of this species was described in 1890 by Cabot,¹ who gives a fair figure, but whose description, probably from the lack of



FIGS. 148-153.—*MACROMIA MAGNIFICA*, NYMPH. 148. LABIUM. 149. ABDOMEN. 150. SEGMENTS 8-10 OF ABDOMEN, VENTRAL VIEW. 151. "FACE". 152. LATERAL VIEW OF HEAD. 153. ANTENNA.

FIGS. 154-158.—*MACROMIA ILLINOENSIS*, NYMPH. 154. LABIUM. 155. ABDOMEN. 156. SEGMENTS 8-10 OF ABDOMEN, VENTRAL VIEW. 157. LATERAL VIEW OF HEAD. 158. ANTENNA.

¹ Cabot, Louis. Immature stages of the Odonata: Cordillina. Mem. Mus. Comp. Zool., vol. 17, 1890, p. 18, pl. 2, figs. 2, 2a.

sufficient material, does not indicate the few points which distinguish this nymph from that of *illinoensis*. Cabot's type was obtained at Umatilla, Oregon, probably in the Umatilla River, rather than the

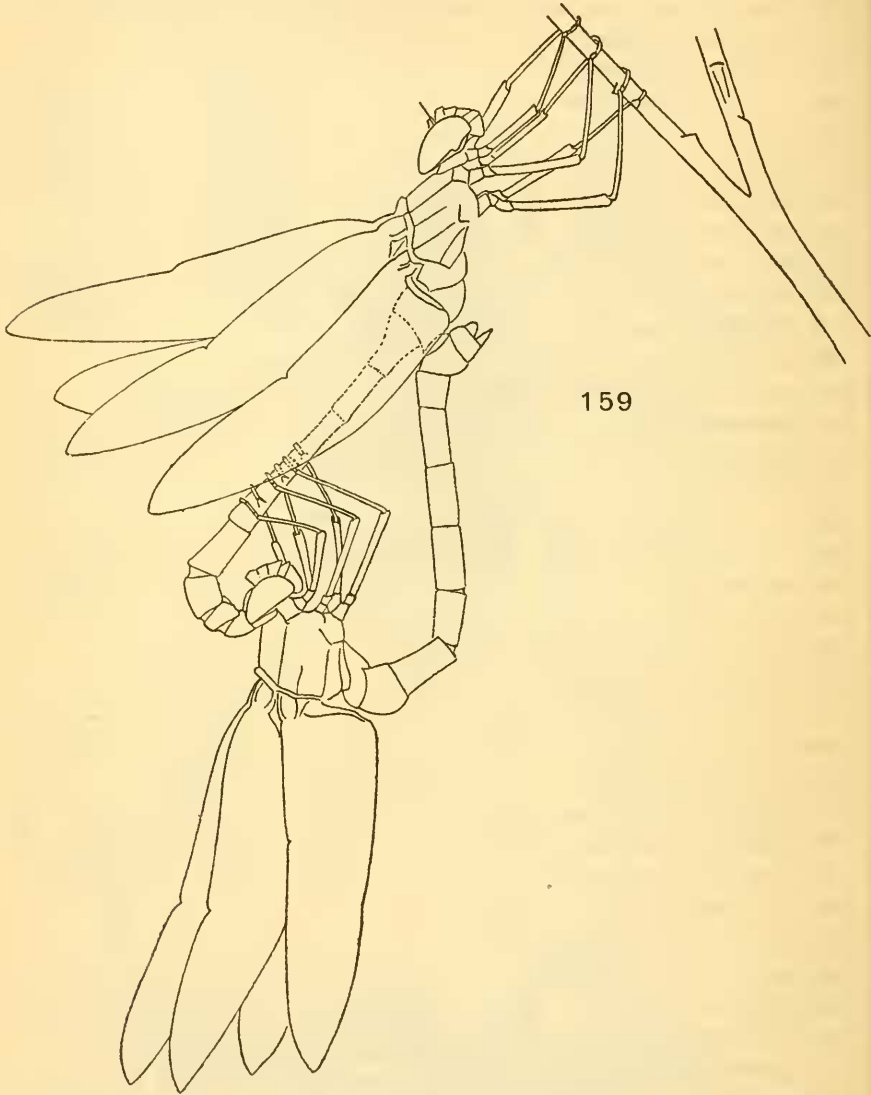


FIG. 159.—*MACROMIA MAGNIFICA*, COPULATION.

Columbia (the town of Umatilla is on the bank of the Columbia at the mouth of the Umatilla), for the banks and bed of the Columbia at this point are barren of vegetation. Cabot's determination of the nymph of *magnifica* was omitted from Williamson's¹ review of the

¹ Williamson, Edward Bruce. The North American dragonflies (Odonata) of the genus *Macromia*. Proc. U. S. Nat. Mus., vol. 37, No. 1710, pp. 369-398, pls. 35, 36, Dec. 14, 1909.

genus and from Muttkowski's¹ Catalogue of the Odonata of North America because of its uncertainty, Cabot having called it *magnifica* because he had a female *magnifica* from the same locality.

While I have neither reared this species nor collected it while in the act of emerging, I feel sure that the single nymph and the 14 skins taken are *magnifica* for the following reasons: (1) I took 12 males and 2 females of *Macromia magnifica* on this stream in the same mile-long stretch in which the nymph and skins were collected; (2) no other species of *Macromia* was taken on the creek and none other has been taken in the State of Washington (I have a female *magnifica* from Lake Washington, Seattle, and Dr. E. M. Walker writes that *magnifica* has recently been taken in southern British Columbia); and (3) the nymph and skins were very evidently conspecific, as all agreed in the described peculiarities.

I wish here to thank Doctor Walker for the material of *Macromia illinoiensis* Walsh used in the following comparative description. This description is based on the single nymph deposited in the United States National Museum, but it applies equally well, except in color, to the 14 nymphal skins.

Nymph.—Length, 31 mm.; length of abdomen, 20, width, 11.5; width of head, 8; length of hind femur, 13.5 (in skins, 14); length of antenna, 5.

Head broader than long, with short appressed hairs on the anterior horn, on the bases of the antennae, and on the sides below and behind the eyes. Horn acute, densely hairy, and more erect than in *illinoiensis* (fig. 152, *magnifica*; fig. 157, *illinoiensis*). Eyes very prominent (see fig. 151), but hardly more so than in *illinoiensis*. Antennae (fig. 153, *magnifica*; fig. 158, *illinoiensis*) with first three joints enlarged, second and third joints hairy, fourth joint the longest, fifth the shortest. The whole length of the antenna slightly greater than that of *illinoiensis*. On each hind angle of the head a prominent superior tubercle, which is more sharply defined than in *illinoiensis* (fig. 152, *magnifica*; fig. 157, *illinoiensis*). Sides of mentum straighter, and posterior angles less rounded than in *illinoiensis* (fig. 148, *magnifica*; fig. 154, *illinoiensis*). Usually two setae at base of each lateral lobe on the inner face in *illinoiensis* and but one in *magnifica*. In *magnifica* the mental setae are usually four in a short row on either side, followed at its inner end by a single detached seta, between which and the median line are from one to four shorter irregularly placed setae. In *illinoiensis* each main row of mental setae usually contains five, with a single detached seta at its inner end, and other short irregularly placed setae between it and the median line (fig. 148, *magnifica*; fig. 154, *illinoiensis*).

¹ Muttkowski, Richard A. Catalogue of the Odonata of North America. Bull. Pub. Mus. Milwaukee, vol. 1, art. 1, pp. 207, May, 1910, issued June 27, 1910.

Abdomen very similar to that of *illinoensis* but differing in three particulars: (1) The dorsal spines of segments 2 and 3 are straight, whereas they are slightly hooked in *illinoensis* (fig. 149, *magnifica*; fig. 155, *illinoensis*). (2) The lateral spines on segment 9 do not reach the posterior margin of segment 10, whereas in *illinoensis* they surpass segment 10 (fig. 150, *magnifica*; fig. 156, *illinoensis*). (3) The posterior edge of the sternum of segment 9 is fringed with hairs, whereas in *illinoensis* there are seldom more than two to four short hairs to be found on this edge (fig. 150, *magnifica*; fig. 156, *illinoensis*).

General color of live nymphs dirty olive, in detail as follows (see figs. 146 and 147): Antennae pale, no markings. Frontal horns dark. Eyes and triangular areas between them, which represent the adult eyes, dark. Parts of head posterior to eyes pale. Dorsal surfaces of thorax and wing pads dark brown, which, excepting the eyes, are the darkest areas of the nymph. Legs with three bands on the femur; tibiae dotted, with hind legs the darkest. Dorsal surface of abdomen mottled and speckled with olive brown, with a more or less well defined spot on the outer end of each segment. All ventral surfaces of the larva pale.

In Needham's key to nymphs of *Macromia*,¹ *magnifica* would come under division "a." Thus:

- a*¹. Lateral spines of abdomen directed posteriorly, hardly incurved. Pyramidal frontal horn acute at apex.
*b*¹. Dorsal spines on abdominal segments 2 and 3 straight.....*magnifica*.
*b*². Dorsal spines in abdominal segments 2 and 3 slightly hooked at tip.....*illinoensis*.
*a*². Lateral spines of abdomen strongly incurved at tip. Pyramidal horn on front of head obtuse.....*taeniolata*.

I have taken *magnifica* in California on Coyote Creek in Santa Clara County, where it emerged early in May and was on the wing about six weeks; also on Chico River, on a small creek near Oroville, June 12, and on the asylum grounds at Napa, June 8. Numerous exuviae have been found at these places and none over 2 feet above the water.

5. SOME LISTS OF ODONATA COLLECTED IN WASHINGTON AND OREGON FROM 1909 TO 1913.

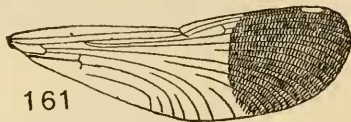
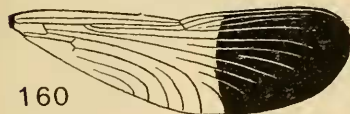
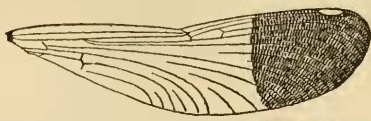
The fifth part of this paper is devoted to lists of Odonata from various localities in which I have collected in Washington and Oregon. Various notes on habits of imagoes and descriptions of nymphal stages have been inserted in these lists as being the most logical place for them.

BAKER VALLEY, OREGON.

During the summer of 1909 I collected in the Baker Valley of eastern Oregon. This valley lies at an elevation of 3,400 feet in the Blue Mountains. The floor of the valley lies in the sagebrush,

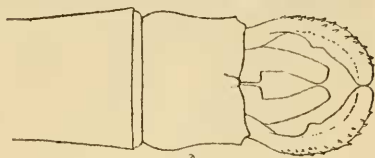
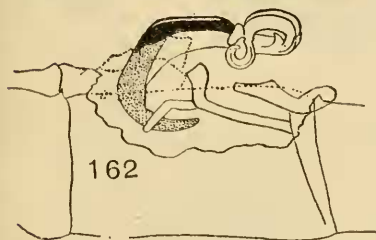
¹ Needham, James G., and Betten, Cornelius. Aquatic Insects of the Adirondacks. Bull. 47, N. Y. State Mus., pp. 612, September, 1901. See p. 483.

but on the west side rise the timber-covered Elkhorn Mountains. The Powder River winds through the center of the valley, but after the first run-off of snow water this stream is hardly more than a



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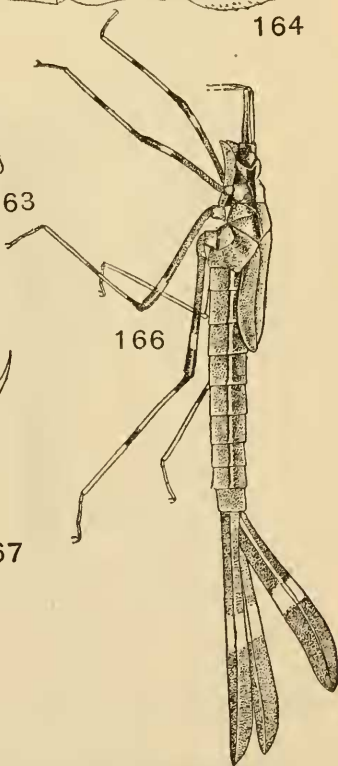


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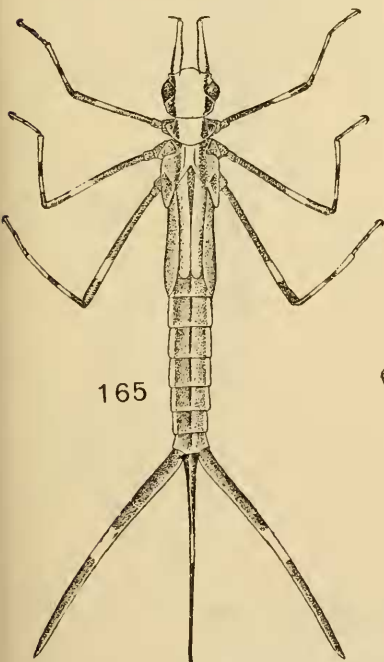
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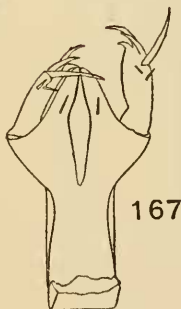
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FIGS. 160-167.—*AGRION AEQUABILE* YAKIMA. 160-161. WINGS OF MALE AND FEMALE SHOWING EXTENT OF COLOR. 162. SEGMENT 2 OF MALE. 163. PENIS. 164. MALE APPENDAGES. 165-166. NYMPH. 167. DORSAL VIEW OF LABIUM OF NYMPH.

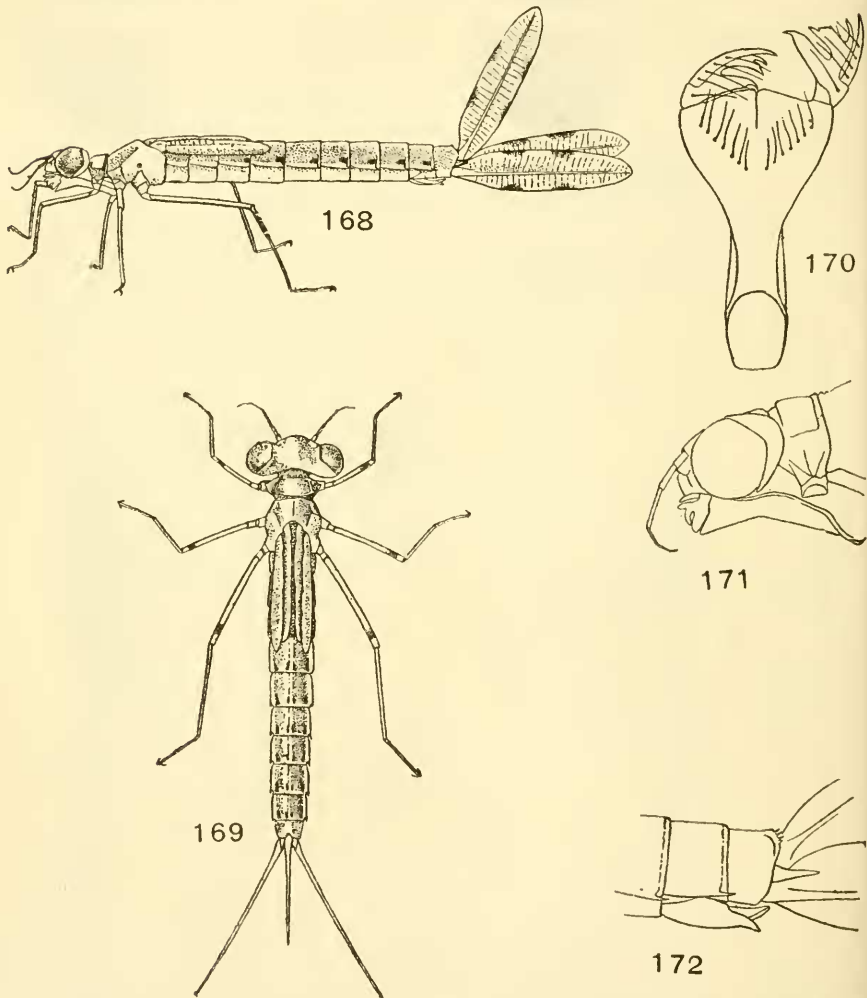
succession of gravel bars, with but little odonate life. The channel of the river, however, is higher than either side of the valley floor, which makes, on each side of the valley and parallel with the river,

a slough that empties into the river at the foot of the valley. These sloughs are alkaline, though with a sluggish current.

The following species were taken on the William Hindman ranch 4 miles west of Baker City on the west slough during July, 1909:

1. *LESTES CONGENER* Hagen.

One male specimen.



FIGS. 168-172.—*LESTES CONGENER*, NYMPH. 168. LATERAL VIEW. 169. DORSAL VIEW. 170. LABIUM. 171. HEAD, LATERAL VIEW. 172. SEGMENTS 9 AND 10.

2. *LESTES UNCATUS* Kirby.

This was common about the stagnant alkaline pools.

3. *LESTES UNGUICULATUS* Hagen.

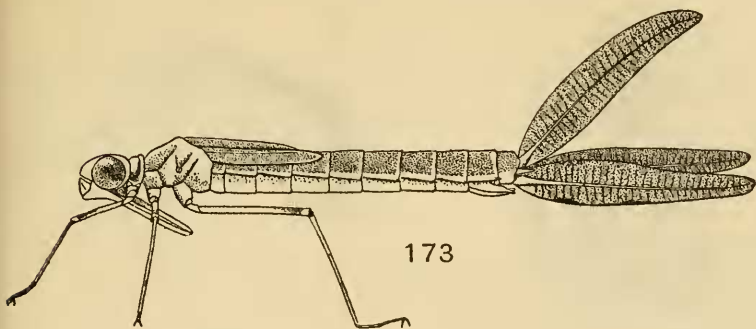
This occurred commonly with the preceding species.

4. *LESTES DISJUNCTUS* Selys.

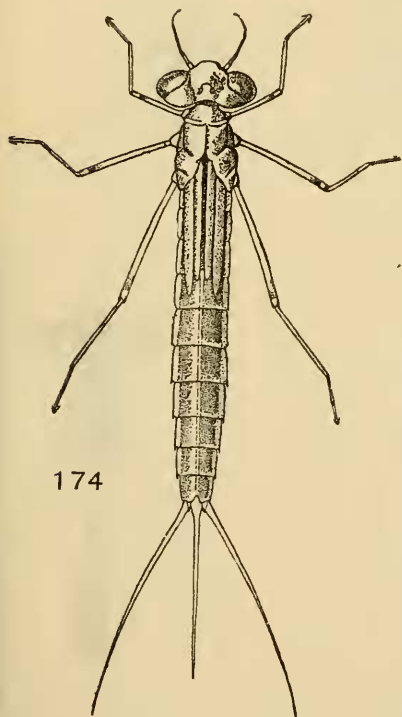
Two males of this species were taken.

5. ENALLAGMA ANNA Williamson.

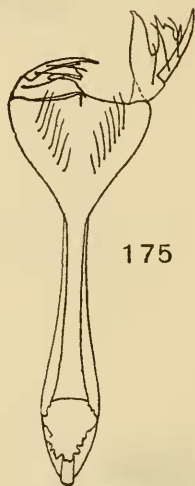
Common, breeding on the fresher of the stagnant pools.



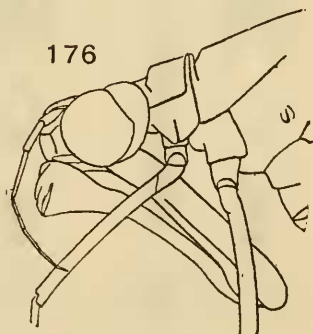
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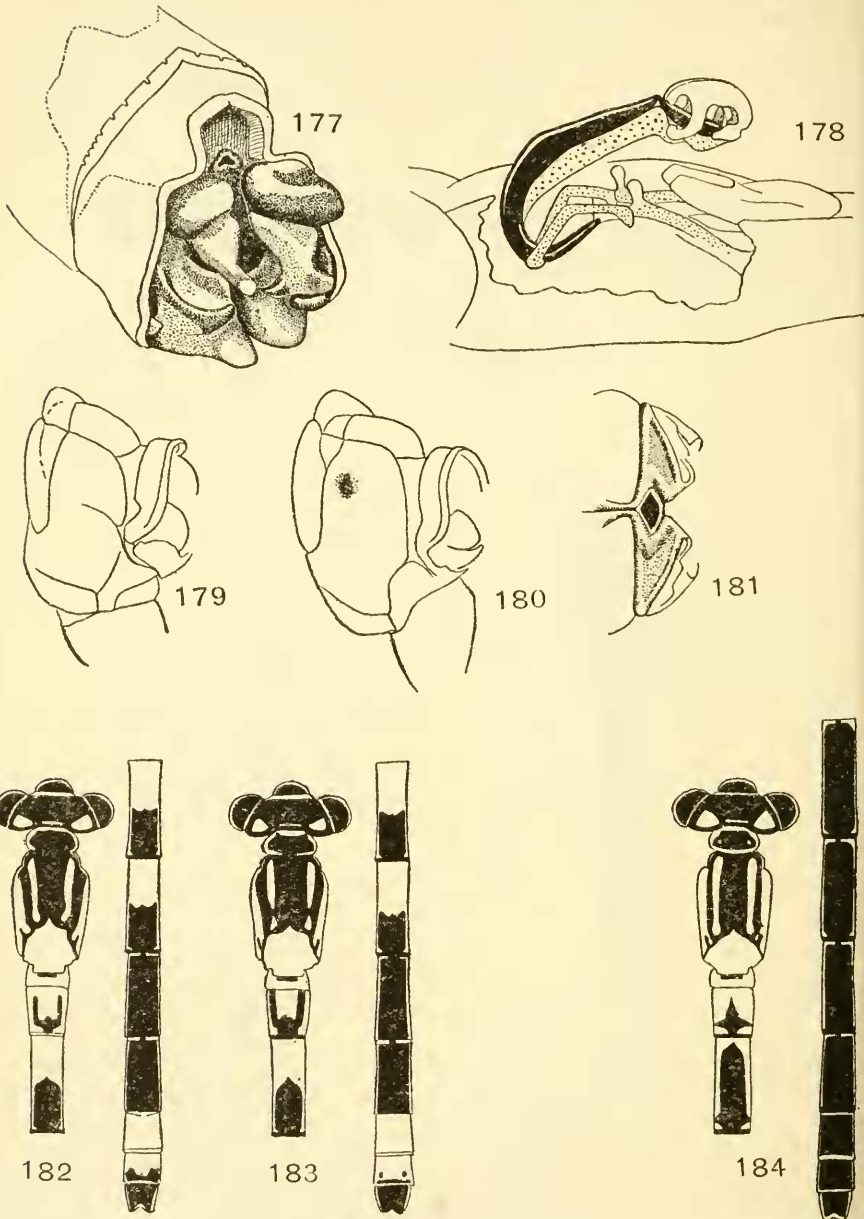
FIGS. 173-176.—LESTES UNCATUS, NYMPH. 173. LATERAL VIEW. 174. DORSAL VIEW. 175. LABIUM. 176. HEAD.

6. ENALLAGMA CALVERTI Morse.

Common, associated with *anna* but earlier.

7. ENALLAGMA CYATHIGERUM (Charpentier).

One male taken.



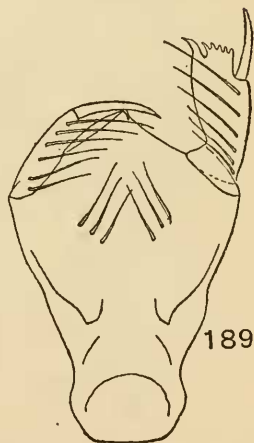
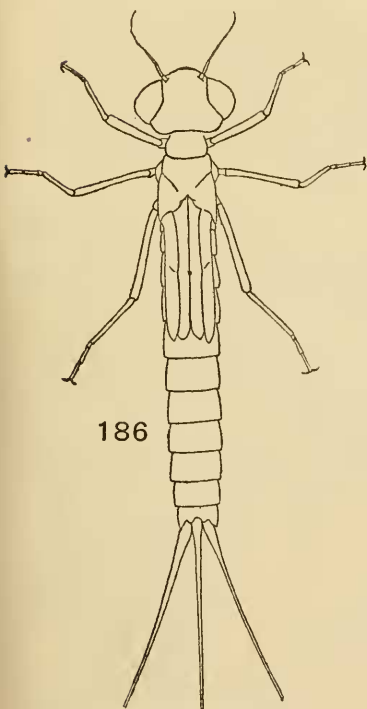
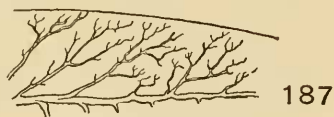
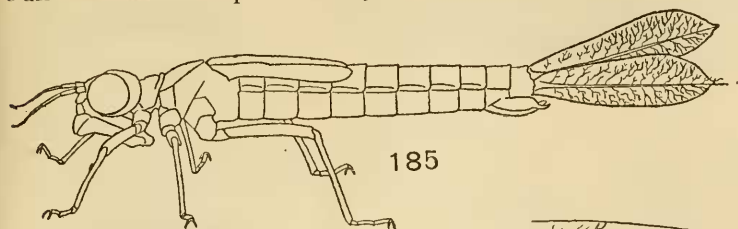
FIGS. 177-184.—*COENAGRION RESOLUTUM*. 177. MALE APPENDAGES. 178. SEGMENT 2 AND PENIS. 179. MALE PROTHORAX. 180. FEMALE PROTHORAX SHOWING THE RIGHT DORSAL "PIT" (IN BLACK). 181. MESOSTIGMAL LAMINA. 182-183. MALE COLOR PATTERNS. 184. FEMALE COLOR PATTERN.

8. *AMPHIAGRION SAUCIUM* (Burmeister).

This was the earliest and most abundant species. It had largely disappeared by July 1, when the season was opening for the other species.

9. *ISCHNURA CERVULA* Selys.

This was at the height of its abundance during the last part of June and the first part of July.



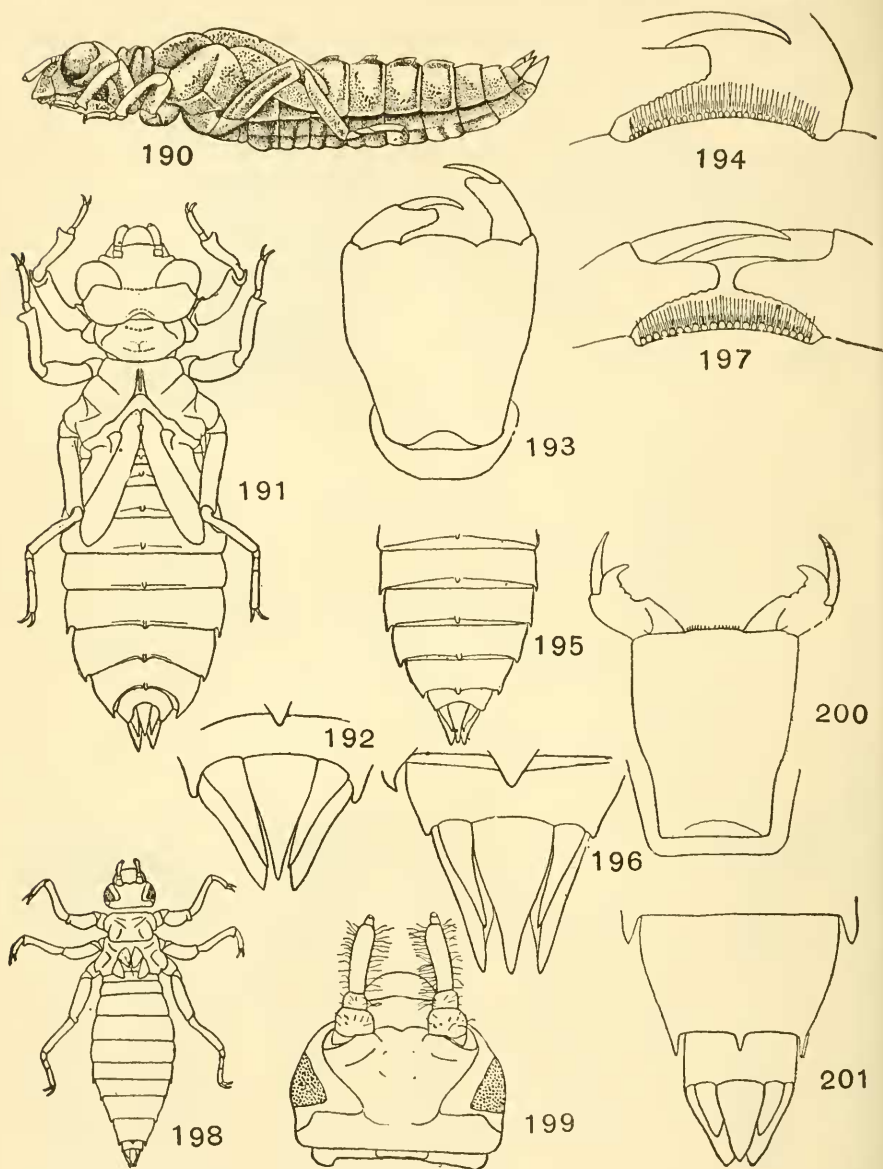
FIGS. 185-189.—*COENAGRION RESOLUTUM*, NYMPH. 185. LATERAL VIEW. 186. DORSAL VIEW. 187. DETAIL OF CAUDAL GILL. 188. LATERAL FOLD OF ABDOMEN SHOWING THE SPINULOSE EDGE. 189. LABIUM.

10. *ISCHNURA PERPARVA* Selys.

Found throughout the summer but not abundant.

11. *AESHNA INTERRUPTA INTERNA* Walker.

This species came out during July but was not so abundant as the next species. On the wing it appeared gray.



FIGS. 190-194.—*OPHIOGOMPHUS SEVERUS*, NYMPH. 190. LATERAL VIEW. 191. DORSAL VIEW. 192. SEGMENT 10. 193-194. LABIUM.

FIGS. 195-197.—*OPHIOGOMPHUS OCCIDENTIS*, NYMPH. 195. ABDOMEN, DORSAL VIEW. 196. SEGMENT 10. 197. LABIUM.

FIGS. 198-201.—*GOMPHUS* SP. 198. DORSAL VIEW. 199. HEAD. 200. LABIUM. 201. SEGMENTS 9 AND 10.

12. *AESHNA UMBROSA OCCIDENTALIS* Walker.

This species was very abundant during the latter part of July. It was first seen July 10.

13. *LIBELLULA QUADRIMACULATA* Linnaeus.

Two specimens of this species were seen during August. One was taken.

14. *LIBELLULA PULCHELLA* Drury.

This species was common but not abundant at any place.

15. *SYMPETRUM CORRUPTUM* (Hagen).

One pair was taken.

16. *SYMPETRUM COSTIFERUM* (Hagen).

Common, but not so abundant as *decisum*.

17. *SYMPETRUM OBTRUSUM* (Hagen), var. *DECISUM* (Hagen).

The most abundant of the *Sympetrum*s.

18. *SYMPETRUM MADIDUM* (Hagen).

This species was common during June and July but was not taken during August.

19. *SYMPETRUM PALLIPES* (Hagen).

Several specimens taken. Not common.

20. *SYMPETRUM SCOTICUM* (Donovan).

This species appeared during the first week in August. It was at first very abundant in a grassy slough. The individuals soon spread from this over a wide territory.

EAGLE VALLEY, OREGON.

From September 7 to 19, 1909, I collected at New Bridge, Baker County, Oregon, in a small valley called Eagle Valley. Here the collecting was done along the banks of Eagle Creek, but the specimens collected came from a series of sloughs more or less alkaline, which ran parallel to the creek. The creek was a cold gravel-bottomed mountain stream almost dry from its waters having been used for irrigation in this part of its course. This valley was lower (2,500 feet altitude) and warmer than Baker Valley.

1. *LESTES UNGUICULATUS* Hagen.

Several specimens taken.

2. *ENALLAGMA ANNA* Williamson.

Several taken.

3. *AMPHIAGRION SAUCIUM* (Burmeister).

Several taken.

4. *ISCHNURA CERVULA* Selys.

Occasional.

5. *ISCHNURA PERPARVA* Selys.

Common.

6. *AESHNA PALMATA* Hagen.

This species was common. No teneral were seen. It was in company with *Aeshna umbrosa occidentalis* and had apparently identical habits, as both patrolled the smaller, more stream-like sloughs, especially where these were surrounded by trees. Both

seemed to prefer such sunny glades to the more open spaces. In both species the males were much more abundant than the females.

7. *AESHNA UMBROSA OCCIDENTALIS* Walker.

Of the two species of *Aeshna* this was the more abundant. This material in *Aeshna* from eastern Oregon has been identified by Dr. E. M. Walker, and in his monograph¹ further notes can be found on it.

8. *LIBELLULA PULCHELLA* Drury.

Common.

9. *SYMPETRUM COSTIFERUM* (Hagen).

Common.

10. *SYMPETRUM OBTRUSUM* (Hagen).

This was common in the blue-grass pasture back of Mr. Blue's barn, but not so abundant as the next. This small white-faced *obtrusum* was only found here. At all other places in which collections were made the variety *decisum* was taken.

11. *SYMPETRUM OBTRUSUM* (Hagen), var. *DECISUM* (Hagen).

Abundant.

12. *SYMPETRUM MADIDUM* (Hagen).

One specimen taken.

13. *SYMPETRUM PALLIPES* (Hagen).

Common.

14. *SYMPETRUM SCOTICUM* (Donovan).

Very abundant.

15. *SYMPETRUM SEMICINCTUM* (Say).

Found only about Mr. Blue's ice pond. This species was not found in either Baker or Pine Valleys.

PINE VALLEY, OREGON.

From September 20 to 23 I collected in Pine Valley, Baker County, Oregon. This is a high cold valley (3,000 feet elevation) but has a greater rainfall than Baker Valley. A heavy frost occurred at Pine Town on September 21. The dragonfly season was practically over. The following species were taken: *Aeshna umbrosa occidentalis* Walker, *Sympetrum pallipes* (Hagen), and *S. scoticum* (Donovan).

GRANDE RONDE VALLEY, OREGON.

On September 30, 1909, I collected in Grande Ronde Valley near LaGrande, Oregon. I took the following species: *Aeshna umbrosa occidentalis* Walker, *Sympetrum costiferum* (Hagen), *S. obtrusum* (Hagen), *S. obtrusum* (Hagen) var. *decisum* (Hagen), *S. scoticum* (Donovan), and *S. pallipes* (Hagen).

¹ Walker, E. M. The North American Dragonflies of the Genus *Aeshna*. Univ. of Toronto Studies, Biol. Ser., No. 11, Toronto, pp. 213, pls. 28, text figs. 7, 1912.

LIBERTY LAKE, WASHINGTON.

On July 4, 1912, I collected at Liberty Lake in the Mica Mountains, east of the city of Spokane, Washington.

The Mica Mountains rise about 1,000 feet above Spokane Valley and are covered with pine timber. The foothills and the Spokane Valley floor lie in the sage brush. Liberty Lake is a narrow body of water 2 miles long and three-fourths of a mile wide lying in the outer end of a deep V-shaped ravine running back into the mountains. The upper end of the lake is in the timber, the lower end in the sage brush. The shores of the lake are steep, except at outlet, where the water flows sluggishly through low weedy banks, and the upper end, where there is a triangular marsh of about 20 acres in extent. The following species were taken:

1. *ENALLAGMA CARUNCULATUM* Morse.

Several taken in outlet.

2. *ENALLAGMA CYATHIGERUM* (Charpentier).

Found in outlet.

3. *ENALLAGMA EBRIUM* (Hagen).

This was very abundant in the *Scirpus* fringing the lake shore along the swamp at its upper end.

4. *AMPHIAGRION SAUCIUM* (Burmeister).

A few were taken about the outlet.

5. *ISCHNURA CERVULA* Selys.

Several seen in the outlet.

6. *ISCHNURA PERPARVA* Selys.

Common in the outlet.

7. *AESHNA UMBROSA OCCIDENTALIS* Walker.

Four male nymphs and one female nymph of this species were found in the outlet. These were very kindly identified by Doctor Walker. Several Aeshnas were seen on the wing but no adults were taken.

8. *TETRAGONEURIA SPINIGERA* Selys.

Several were captured in the swamp at the head of the lake.

9. *LIBELLULA QUADRIMACULATA* Linnaeus.

Several were seen in the swamp at the head of the lake.

10. *LIBELLULA FORENSIS* Hagen.

This species was common in the outlet.

11. *SYMPETRUM CORRUPTUM* (Hagen).

Two specimens were captured in the outlet.

12. *SYMPETRUM OBTRUSUM* (Hagen), var. *DECISUM* (Hagen).

Emerging in large numbers in the swamp.

13. *SYMPETRUM PALLIPES* (Hagen).

Emerging from the swamp in numbers.

PALOUSE VALLEY, WASHINGTON.

During June of 1913 Prof. C. E. Farr, of Sunnyside, Washington, took the following species in the Palouse Valley: *Enallagma cyathigerum* (Charpentier), *Amphiagrion saucium* (Burmeister), *Ischnura cervula* Selys, and *Ischnura perparva* Selys.

During August of 1914 Professor Farr collected the following on Union Flat Creek, Palouse, Washington: *Argia emma* Kennedy, *Ischnura cervula* Selys, *Ischnura perparva* Selys, *Enallagma calverti* Morse, *Libellula pulchella* Drury.

SHERMAN, OREGON, IN THE COLUMBIA RIVER GORGE.

During the first week in July, 1913, I made a short trip up the Deschutes River to Bend, Oregon.

My first stop was made on July 2 in the Columbia River Gorge at Sherman, Oregon. Here the Columbia River, a half mile broad, flows through a gorge from 1,500 to 2,000 feet deep. The sides are precipitous brown hills, barren except that here and there is a green spring-fed ranch on some bench 500 or 1,000 feet above the river. The bottom of the gorge on either side is a narrow strip of white sand dunes. Among these is the box-car station called Sherman. The collecting at this point was done in a narrow lateral ravine, up which the Y of the Deschutes River ran. A half mile from the Columbia this ravine becomes a rocky gorge. I collected in the more open mouth of the ravine, where the cool spring-fed stream coming down from above runs through a succession of shallow boggy ponds. At this point, during the two hours I had to wait for the Deschutes train, I took the following species:

1. ARGIA VIVIDA Hagen.

This was the most abundant species, the majority apparently having recently transformed, as many teneral were found. This species fairly swarmed over the smooth round boulders scattered everywhere along the course of the stream. It was abundant also along the bank of the Columbia east of the mouth of the lateral ravine, whither it had evidently been carried by the half gale which blows up the Columbia daily. This species was not seen copulating or ovipositing.

2. ENALLAGMA CYATHIGERUM (Charpentier).

A few were found about some of the larger pools well back in the ravine.

3. AMPHIGRION SAUCIUM (Burmeister).

Amphiagrion was very abundant about a single pool not far from the beach of the Columbia. This pool was very thickly grown up with sedges. Breeding was in progress.

4. ISCHNURA PERPARVA Selys.

Common in the sedges with *Amphiagrion*.

5. *OPHIOGOMPHUS OCCIDENTIS* Hagen.

A single specimen was taken on the bank of the Columbia at the mouth of this ravine. It was the only one seen.

6. *ANAX JUNIUS* (Drury).

I did not capture one of these, but one or two were coursing up and down the ravine. I feel sure of the identification.

7. *LIBELLULA FORENSIS* Hagen.

Several were seen and one was taken.

8. *LIBELLULA PULCHELLA* Drury.

One was seen.

9. *ERYTHEMIS SIMPLICICOLLIS* (Say).

Three were seen.

10. *SYMPETRUM CORRUPTUM* (Hagen).

Four were seen. One was taken.

BIG MEADOWS, BEND, OREGON.

From Sherman I went by train up the Deschutes Canyon to Bend, Oregon.

The Deschutes is the largest tributary of the Columbia from central Oregon. Arising at an elevation of over 4,000 feet, in the 300 miles of its course to the Columbia it falls over 13 feet to the mile, making it a swift boisterous stream flowing for the greater part of its distance through a canyon from 1,000 to 3,000 feet deep. During the three hours' train ride through this canyon observation showed but two or three tributaries and these were merely very small spring-fed streams. About half way up the canyon at Hunter's Ferry several very large springs burst from the walls of the canyon and may have supported odonate species in their short courses to the river, but rainy weather prevented my stopping there.

At the town of Gate Way the railroad leaves the canyon and through a lateral gorge emerges onto the central Oregon plateau, which is a barren, brown, sage-covered region with here and there low ridges or detached volcanic buttes. To the west lie the blue timber-covered Cascades above which tower the white cones of several volcanic peaks. South of Bend, the Valley of the Deschutes is wide and shallow and lies in the timber, which covers the eastern slope of the Cascades. The river, where examined at its mouth on the Columbia and at Bend, was practically devoid of odonate life. The season was late and the water was high.

On the Deschutes 18 miles south of Bend lie the Big Meadows, which are about 1,000 acres in extent, and which, in contrast to the rarity of Odonata elsewhere on the river, fairly swarm with dragonflies. At a recent time geologically a volcanic eruption has occurred on the east slope of the valley at what is now the lower end of the Meadows. Here is a small cinder cone, from whose base radiates a

lava field of several sections in extent, which has flowed down into the Deschutes gorge damming the river so that its present bed is 500 or 600 feet above the primitive channel. The lake, which was formed back of this dam, is now filled with sediment and forms the Big Meadows. These lie at an elevation of 4,000 feet, and a frost had occurred there on July 4. The Meadows are surrounded by yellow and jack pine over the western rim of which rises the snow-capped Bachelors Peak. Several shallow sloughs, which are filled by springs and by high stages of the river, occur here and each is a favorite resort of special species.

I spent four days here (July 4-7) at the ranch of Mr. F. A. Shonquest, who helped me in various ways. The following is a list of the species found:

1. *AGRION AEQUABILE* (Say).

One specimen was seen on the meadow near Mr. Shonquest's meadow road. One, a female teneral, was taken just above the lava dam (Denham Falls). At the time I took this I thought it the variety *yakima*, but it has faded until now it is impossible to determine the subspecies. As the numbers of *aequabile* reached their height later than this on the warmer Satus Creek, Washington, I believe this an early date for the species here.

2. *LESTES UNCATUS* Kirby.

Very abundant in sedges along the river and in the first slough across the river from Shonquest's. The adults are rich blue-green. Breeding, but still emerging in large numbers. Though described by Needham, because of the abundance of material I have figured the nymph.

Nymph (figs. 173-176).—Needham¹ has listed the nymph of *Lestes uncatatus* in a key to the species of *Lestes*, but he does not distinguish it from the nymph of *unguiculatus*. Whether it can be distinguished on further study I do not know, as I have no nymphs of *unguiculatus*. But as I had excellent specimens of both nymphs and skins of *uncatus* I have thought it best to figure this nymph, which differs in various ways from the nymph of *congener* (figs. 168-172).

This nymph is more slender than that of *congener* and considerably larger. Its measurements are as follows: Head, 4 mm. wide, 2 mm. long; length of head, thorax, and abdomen, 28; gills, 10 extra; abdomen, 13.5; hind femur, 5.

In this species the folded labium (fig. 175) is very slender, its hinge reaching caudad beyond the metathoracic coxae (see figs. 173 and 176), whereas in *congener* (figs. 168, 170, 171) it reaches barely to the mesothoracic coxae. The basal two-thirds of the mentum is almost triangular in outline. There are normally seven mental setae, though one specimen had only six. There are two setae on the movable hook

¹ Needham, James G., MacGillivray, Alex. D., Johannsen, O. A., and Davis, K. C. Aquatic Insects in New York State. Bull. 68, N. Y. State Mus., pp. 517, pls. 52, text figs. 26, 1903. See p. 233.

of the lateral lobe and a single seta on the inner face of the base of the lateral lobe. The eyes are relatively large, occupying two-fifths of the width of the head. Segments 6-9 have a well-defined spine on each side at the posterior end of the lateral keel. Segment 5 has usually a pair of small spines. Segments 1-4 are without spines.

The gills (see fig. 173) are slightly asymmetrically lanceolate, with rounded tips. The middle gill is wider than the lateral gills and curves downward. The lateral gills curve upward.

In life the larvae (figs. 173 and 174) were dusky olive green. The legs show a slight band around the end of the femur. There is a pale stripe along each side of the abdomen. In some specimens there is a narrow middorsal white stripe, in others a row of faint darker spots along the sides. The gills are uniformly dark, a few specimens showing slightly darker spots on the edges of the lateral gills.

Figures 173 and 174 show dorsal and lateral views of the nymph, and figures 175 and 176 show details.

3. ENALLAGMA CYATHIGERUM (Charpentier).

This species occurred in the sedges along the river bank, but was nowhere abundant.

4. COENAGRION RESOLUTUM (Hagen).

This species (figs. 177-184) was very abundant in the sedges and patches of *Equisetum* bordering the river itself. I found many females, evidently in a teneral stage, but only two exuviae. The teneral females had the sides of the thorax and femora pink. In the male the blue humeral stripes in about one-fourth of the specimens were interrupted as is shown in figure 183. As I can find no figures of the anatomical details of this species I have figured various parts (see figs. 177-181). The mesostigmal lamina of the female (fig. 181) is especially large and well developed.

Because I found only two exuviae and but few very young tenerals, I believe that all individuals of this species, at least in this locality, must emerge at about the same time and that this general emergence had been previous to my arrival. Of the exuviae one was taken by itself a few inches above the surface of the water, the other was found on a stem of *Carex*, on the top of which rested a teneral female. The only other species found in the meadows with whose exuviae they might be confused were *Ischnura perparva*, *Ischnura cervula*, and *Enallagma cyathigerum*. They are not the exuviae of any of these species.

Nymph (figs. 185-189).—Length (excluding gills), 15 mm.; gills, 8 extra; abdomen, 8; hind femur, 3.

The nymph (figs. 185 and 186) is slender, between those of *Argia* and *Enallagma* in slenderness. The head (see fig. 186) is broad, very flat on the dorsal surface, and very slightly emarginate behind. The antennae are one-fourth longer than the head. The labium (fig. 189)

is very similar to that of an *Enallagma*. The anterior edge is produced forward and downward into an acute angle. Three mental setae on each side; six long raptorial setae on each lateral lobe. Each lateral lobe terminates distally in a hook, which is separated by a deep cleft from the terminal row of five short teeth.

The legs are moderate in length, with three low keels on femur and tibia. Wing cases long, reaching to the middle of segment 4, slender and held parallel. Abdomen with large lateral keels, which are denticulate with minute teeth. (See fig. 188.) Gills (see figs. 185 and 187) ob lanceolate.

The coloration is so obscure that I will not attempt to describe it.

The nymph is of a generalized form lying near to the nymphs of *Enallagma*, but is peculiar in having the denticulate lateral keels.

These specimens are deposited in the United States National Museum.

5. AMPHIGRION SAUCIUM (Burmeister).

This species was common, but nowhere in swarms as it is frequently found in such situations.

6. ISCHNURA CERVULA Selys.

One or two individuals of this species were taken each day. The meadows were probably too high and cold for it.

7. ISCHNURA PERPARVA Selys.

A few specimens of this were taken.

8. OPHIOGOMPHUS MORRISONI Selys.

One specimen, a male, was taken on a sandy bank of the river. Two other specimens, probably this species, were seen on Mr. Shonquest's corduroy road.

9. ANAX JUNIUS (Drury).

One specimen was seen late in the afternoon beating back and forth over one of the sloughs.

10. AESHNA INTERRUPTA INTERNA Walker.

One female was taken in the timber near the meadows. As this was a teneral and, excepting one male, the only *Aeshna* seen, it was probably early for *Aeshnas*.

11. CORDULIA SHURTLEFFI Scudder.

One male taken over a grassy slough near Mr. Shonquest's bridge. A female was taken in the bushes just above Denham Falls.

12. SOMATOCHLORA SEMICIRCULARIS (Selys).

This species was very common over those grassy sloughs in which sedges grew up through from 6 inches to 2 feet of water. Usually, too, these were surrounded by timber in which the *Somatochloras* took occasional side flights, especially late in the afternoon, when they seemed to prefer the sunny tops of the trees to the cooler sloughs. I took 80 males and only 2 females. The females were probably more abundant, but because of their gray colored eyes and plump abdomen they were indistinguishable from the swarm of *Libellula quadrimaculata*.

lata which always hovered over the sloughs. The two females taken were scooped up accidentally. The males were distinguishable on the wing endwise by their bright green eyes and sidewise by their curved abdomen. None of the specimens were teneral. In these specimens the spots on the side of the abdomen were minute points. All degrees of striping of the nasus occurred.

13. *LIBELLULA FORENSIS* Hagen.

This was not common. I took one specimen at Denham Falls.

14. *LIBELLULA QUADRIMACULATA* Linnaeus.

I have never elsewhere seen a large species of dragonflies as abundant as was this species. Over the same grassy sloughs as those occupied by *Somatochlora*s, these *Libellulas* were a constant annoyance during collecting, either disturbing other species or imitating their flight.

15. *SYMPETRUM CORRUPTUM* (Hagen).

I took two frayed females on the meadows.

16. *SYMPETRUM MADIDUM* (Hagen).

The males and females of this species are seldom found associated except at time of emergence. The males were common along the higher open banks of the sloughs, where I saw no females, and the females could always be found on the corduroy road, where I saw no males. (On lower Satus Creek, Washington, I have never taken a male, but females were common.) None of the specimens were teneral.

17. *SYMPETRUM OBTRUSUM* (Hagen).

Several specimens were taken in the early red, which were probably *obtrusum*.

18. *SYMPETRUM OBTRUSUM* (Hagen), var. *DECISUM* (Hagen).

This variety was swarming out of the sloughs more directly connected with the river channel. All were teneral. Some seemed intermediate between this and *obtrusum*, the face being white with an olive cast. Two females had wings yellow to beyond the nodus. All the specimens showed more than the usual amount of yellow at the base of the wings.

19. *SYMPETRUM PALLIPES* (Hagen).

This species was emerging in large numbers. None but teneral were taken.

20. *LEUCORRHINIA HUDSONICA* (Selys).

This species was common in the sloughs, where the grass was more open so that the surface of the water was exposed. They spent most of their time seated on the tops of aquatic plants. They copulated on the wing, the male picking up the female as she sat on some plant. The flight was short, after which the male dropped the female but hovered near, while she oviposited by tapping the tip of her abdomen repeatedly on the surface of the water.

21. *LEUCORRHINIA INTACTA* (Hagen).

This species occurs with *hudsonica* but was not so abundant.

UMATILLA, OREGON.

On my return from the Deschutes I collected at Umatilla, Oregon, on July 8 and 9. Umatilla is a railroad yard among the sandhills at the mouth of the Umatilla River. A gale was blowing during this time but I found the following species: *Enallagma carunculatum* Morse, *Ophiogomphus occidentis* Hagen, *Ophiogomphus severus* Hagen, *Aeshna multicolor* Hagen, *Libellula forensis* Hagen, and *Sympetrum semicinctum* (Say).

All the species were stragglers except *Ophiogomphus occidentis*. This species was emerging in numbers on the point of land separating the down-stream side of the Umatilla River from the Columbia. From the place of their emergence it appeared that the nymphs lived in the bay or open mouth of the Umatilla River, where they were on a mud bottom and not exposed to the main current of either river. Though the banks of both rivers were searched for some distance none were found emerging elsewhere. Because of the high wind they were easily captured while hanging to the sage bushes among which they had taken refuge. Numerous exuviae were found on the beach and on plants and brush lying in the water. Figures 195-197 show details of the exuviae which have not hitherto been figured.

YAKIMA VALLEY, WASHINGTON.

Collecting in the Yakima Valley, Washington,¹ was done altogether in that part lying between Grandview and North Yakima. This part of the valley lies entirely in the sage brush and, excepting those parts now irrigated, has no mesophytic vegetation except the narrow fringe of trees along the Yakima River and its tributaries, and the swampy areas about the alkaline ponds in the Yakima River bottoms.

I have described Satus Creek in the section on *Argia vivida* and *Argia emma* (pp. 269-270). The Yakima River itself contains but little odonate life. It is a shallow stream during the irrigating season, when most of its water is withdrawn, and is easily forded every mile or so. In the more swift reaches it is gravel bottomed and in the bends mud bottomed. The alkaline ponds fall into two groups, the larger ones between Sunnyside and the Yakima River, the largest of which is Nigger Pond, a half mile long and an eighth mile wide, and the group of smaller fresh ponds near Donald.

1. AGRION AEQUABILE YAKIMA (Hagen) (figs. 160-167).

I saw one specimen of this near Outlook. Otherwise I took it only on lower Satus Creek, where it was abundant. Here it was first seen June 17. It reached its greatest numbers July 27. On August 7 few were seen, and none on August 17.

¹ I have just found a male and female *Tachopteryx hageni* in the collections in the California Academy of Sciences. These are from Monroe, Washington, and will be described in my paper on collecting done in California and Nevada during 1914. Nevada is the type locality of this species.

Figure 160 shows the extent of the dark color on the wings of the male and figure 161 the extent of that on the wings of the female. The second segment of the male is shown in lateral view in figure 162, the penis in figure 163, and the appendages in figure 164. The nymph, shown in figures 165 and 166, is very similar to that of *Agrion maculatum* Beauvois but differs in having a less vivid color pattern. The pattern in life is in various shades of olive green, which dissolves out into the alcohol in which the specimens are placed.

Nymph (figs. 165–167).—Length, 24 mm.; gills, 16 additional; hind femur, 8.5; abdomen, 16; antenna, 5.5.

Head flat and broad. Basal segment of antenna scarcely as long as head is wide, longer than other six segments. Labium (fig. 167) bifid to below bases of lateral lobes. A short mental seta on either side of the cleft. Each lateral lobe with two short setae at base of lateral lobe. Each lateral lobe, besides the movable hook, with three end hooks. Abdomen with segments 1–9 with high lateral keels. No lateral spines on abdomen. Wing cases reaching beyond middle of fourth segment. Gills (see figs. 165 and 166) linear, the lateral gills longer than the median and thicker. Color olive, with an obscure broad lighter stripe on head and thorax. A longitudinal stripe on each lateral abdominal keel and a pale band on each femur, tibia, and gill.

The nymph of the variety *yakima*, then, differs from the eastern nymphs of *aequabile* as described by Needham¹ in its greater size and in having only two setae at the base of each lateral lobe, neither being characters of specific importance.

The female of this species oviposits by inserting the eggs under the water in willow roots. She is unaccompanied by the male but remains indifferent as various males hover over her.

2. ARCHILESTES CALIFORNICA McLachlan.

This species is found along the river and creeks from the first week in August until frost. It is most abundant on Satus Creek.

3. LESTES CONGENER Hagen.

This is common around the sloughs near Toppenish and Donald, but is most abundant on Satus Creek. It also occurs around Nigger Pond. It is an all-summer species, but is most abundant on Satus Creek during August and September.

Nymph (figs. 168–172).—This is described from a single nymphal skin found among *Juncus* stems on the banks of a stagnant pool of Satus Creek, September 3, 1914. *Lestes congener* was abundant at this point and was the only species of *Lestes* found on Satus Creek, though during the summer I made eleven trips at intervals of a week. A pair of *congener* were seen ovipositing a short distance from this point. The male was holding the female and she had her abdomen looped

¹ Needham, James G., Macgillivray, Alex. D., Johannsen, O. A., and Davis, K. C. Aquatic Insects in New York State. Bull. 68, N. Y. State Mus., pp. 517, pls. 52, text figs. 26, 1903. See pp. 222, 223–224.

up as does the female of *Archilestes* and was placing eggs in a small willow stem about 2 inches above the surface of the water. In view of the abundance of *congener*, the lack of other species on the creek, and the careful collecting done, together with the small size of *congener*, with which the single skin agrees, I feel sure that this is the nymphal skin of *congener*.

Length (head, thorax, and abdomen), 17 mm.; gills, 7 extra; abdomen, 12; hind femur, 4.5.

The nymph (figs. 168 and 169) is long and slender, but not so slender as the nymphs of *rectangularis* and others of the larger species of *Lestes*.

Head two and one-half times as wide as long (this measurement may be at fault because of the distortion of the skin). Eyes occupying only half of total width of head. Notch at back of head wide and shallow. Antennae (see fig. 171) with segments 1 and 2 heavy, the second longer than the first, the third to the seventh slender. The segments increase in length to the third and decrease to the seventh, which is minute. Labium (fig. 170) slender, but the base of the mentum not so slender as in *L. rectangularis*. Closed median cleft of median lobe extending below bases of lateral lobes. Mental setae long, a row of seven on either side. A seta on base of each lateral lobe and *four large setae* on each movable hook. Each lateral lobe bears three large hooks, the inner of which is the largest and having on its inner edge a row of minute teeth; the outer hook is second in size. Next the outer side of the middle tooth is a cutting edge of six or seven minute teeth.

Prothorax conic, with the dorsal scutum rectangular. Legs with faint band on distal end of femur.

Abdomen cylindric. Lateral keels of segments 5-9 terminating caudad in a sharp point. (See fig. 172.) Abdomen with lateral white stripe above each lateral carina and a middorsal white stripe. The dorsum of each abdominal segment with four black spots on its distal margin, one above posterior end of each lateral keel, and one on either side of the middorsal white spot. Gills (see fig. 168) oblong-lanceolate, with two dark spots on each edge.

4. **LESTES DISJUNCTUS** Selys.

I find several specimens of this from a slough near Toppenish.

5. **LESTES UNCATUS** Kirby.

Common about the various ponds. The specimens are not so brilliant as those from Bend, Oregon.

6. **LESTES UNGUICULATUS** Hagen.

Found occasionally about alkaline ponds.

7. **ARGIA EMMA** Kennedy.

Common along the streams from the last week in June until September. It is most abundant on Satus Creek south of Alfalfa.

(The Stanford collection contains a specimen from Prescott, Washington.)¹

8. *ARGIA VIVIDA* Hagen.

I have taken this only on Satus Creek. A few specimens were taken south of Alfalfa, but it was much more abundant on Logie Creek, an upper tributary of Satus. It was emerging June 15. Old specimens were taken August 24.

9. *ENALLAGMA CALVERTI* Morse.

Common about alkaline ponds from May to July, when it is displaced by *carunculatum*.

10. *ENALLAGMA CARUNCULATUM* Morse.

This species appears about the alkaline ponds in June and by August is the most abundant species.

11. *ENALLAGMA CLAUSUM* Morse.

I took 2 males on Nigger Pond July 21, 1912.

12. *ENALLAGMA CYATHIGERUM* (Charpentier).

This species is common on the river and running creeks from May to September. It is most abundant in June.

13. *AMPHIAGRION SAUCIUM* (Burmeister).

Nowhere abundant, but occasional about the various ponds.

14. *ISCHNURA CERVULA* Selys.

Found about all the ponds. It reaches its greatest abundance in June, but is the earliest spring species and lasts till frost.

15. *ISCHNURA PERPARVA* Selys.

Found throughout the season, perhaps more abundant about the fresher ponds.

16. *OPHIOGOMPHUS OCCIDENTIS* Hagen.

I have a male and a female taken on Satus Creek south of Alfalfa. The female was caught resting on a willow in copulation with a male *severus*, which was abundant here. The identity of this and the next species I shall discuss in a forthcoming paper based on material collected by me in California.

17. *OPHIOGOMPHUS SEVERUS* Hagen.

Abundant on Satus Creek south of Alfalfa. Here the emergence commenced the second week in June and lasted until the first week in July. It occurred from 9 o'clock in the morning until 4 o'clock in the afternoon, the nymph seldom crawling more than 6 inches from the water. Oviposition was most common on about August 1 and the last specimens were seen August 24. Oviposition occurred almost altogether on the riffles, but emergence was almost altogether along the deeper mud-bottomed pools. In copulation the male sought the female while she rested on a stone. Copulation occurred immediately after the male grasped the female, and after a short

¹ I found this species abundant in California on the Sacramento River at Colusa, on the Feather River at Oroville, and on the Chico River at Chico. The species was emerging June 10 at Colusa and was ovipositing on the Chico River June 17.

flight to a near-by bush the couple would rest in copulation for many minutes. The male did not accompany the female during oviposition. The latter would rest on a stone in a riffle and every few seconds make a short flight, striking the tip of her abdomen on the surface of the water just once, when she would rest for a few seconds on a stone and repeat the process. These short flights were repeated five or six times in succession. By August 1 many individuals showed age in the frayed wings, the olive coloration, and in their difficulty in standing. Frequently when one would attempt to alight on a stone it would fall over on its side or tumble on its head. During the first part of their season they were most abundant on the gravel bars, but during the oviposition period they were most abundant about the riffles.

Figures 190 and 191 show dorsal and lateral views of the nymph of *severus*. Figures 192, 193, and 194 show details of the nymph of *severus* and figures 195, 196, and 197 details of that of *occidentis*.

18. GOMPHUS, SP.

I have several immature nymphs of *Gomphus* which I found in the Sunnyside Canal in 1912.

On November 1 of each year the headgates of the Sunnyside Canal are closed and remain closed until April 1 the following spring. On November 14, 1912, in the mud puddles in the bottom of the canal 36 miles below the headgates, I gathered 10 immature gomphine larvae. Four of these were undoubtedly *Ophiogomphus severus*, while the other 6 are undescribed nymphs belonging in the *Stylurus* subgenus of *Gomphus*. In going over the literature of gomphine nymphs I find that an attempt to assign these a specific identity would be largely a matter of shuffling the suppositions of the various students of *Gomphus*. I think that on two different occasions I have seen imago *Gomphus* on the Yakima River; if so, it is a species difficult to approach.

The six nymphs vary from 7.5 to 15 mm. in length. The abdomen of the longest specimen is 10 mm. long and 4 broad. Segment 9 about one and one-half times as long as 8. A longitudinal dorsal groove with a depressed triangular spine on middle of apical edge of segment 9. Segments 6-9 with lateral spines. Spines on segment 9 one-half as long as the cylindrical segment 10. Labium one and one-fourth times as long as broad. Anterior edge of mentum almost a straight line, bearing 16-18 short, yellow, bristle-like scales. Lateral lobes with large hook curving in sharply at almost a right angle and bearing along its concave inner side 3 to 4 blunt teeth. Outer movable hook well developed. Antennae with third segment one and one-half times as long as first two and with fourth segment a short truncated cone curving upward so that the circular end surface is horizontal.

Figure 198 gives the dorsal view of the largest of these *Gomphus* nymphs and figures 199, 200, and 201 show details of structure of the same specimen.

19. *ANAX JUNIUS* (Drury).

Nigger Pond is the only place at which I saw this species. Here it emerged during July in great numbers, judging from the numerous exuviae clinging to the outer cattails, but during the many days spent in collecting on the pond I saw only an occasional *Anax*. I believe that the yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) which nested in the cattails ate most of the teneral, as a single *Anax* reared by me emerged early in the morning when the blackbirds would be after such conspicuous morsels. I examined several black-bird stomachs with the following results:

CONTENTS OF STOMACHS OF SEVEN BLACKBIRDS.

(1) Stomach of male yellowhead: 13 teneral damselflies, 2 grains of wheat, and a mass of chitinous teneral remains.

(2) Stomach of male yellowhead: 8 wheat grains and a mass of teneral remains.

(3) Stomach of male yellowhead: 8 rye grains, 100 grass seeds (*Panicum?*), 2 teneral Zygoptera, 1 wasp, and a mass of teneral remains.

(4) Stomach of female yellowhead: 2 beetles and a mass of teneral remains.

(5) Stomach of male red-winged blackbird: 1 beetle, 4 teneral damselflies, and a mass of teneral remains.

(6) Stomach of male redwing: A mass of wheat skins and 1 beetle, but no teneral remains.

(7) Stomach of female redwing: 1 beetle, 5 wasps, 4 caterpillars, but no teneral damselflies. This bird carried in its bill 1 moth, 1 fly, and 2 green caterpillars

Anax differs in time of emergence from the two species of *Aeshna* (*californica* and *multicolor*) which swarm about this pond. The *Aeshnas* emerge between 8 and 12 o'clock in the evening, consequently by daylight their wings are hardened and they are safe from black-birds. So far as numbers of exuviae are concerned, *Anax* emerges in as great abundance as either *Aeshna*, but the adults of *Anax* are rare whereas adults of the species of *Aeshna* are abundant.

20. *AESHNA CALIFORNICA* Calvert.

This species appears some years as early as April 1. It is in its season during May and June and is seldom found during July or later. It swarms about those alkaline ponds in which there are few fish, but I have also taken it on the cold torrents (Logie and Dry Creeks) on the Yakima Reservation.

21. *AESHNA MULTICOLOR* Hagen.

This species is abundant about the alkaline ponds from June till August, with the height of the season during July. Both it and *californica* are wide fliers, being found at times several miles from the nearest water.

22. *AESHNA UMBROSA OCCIDENTALIS* Walker.

This species occurs with *palmata* on the streams of the valley, having about the same season and habits. It may emerge a week or two later, as I have teneralis from Satus Creek taken on August 17, when *palmata* was in fresh full colors. The teneral specimens of *umbrosa* are a rich deep chocolate including the upper half of the eyes, which shade into gray below. The teneralis hang on foliage frequently. The females of the species oviposit in the brush and bushes which lie partially submerged in the edges of the quiet side pools. The exuviae are found on the brush and tree roots about the deeper pools.

23. *AESHNA PALMATA* Hagen.

Occurs on streams from August until frost. Perhaps a week earlier than *umbrosa occidentalis* in emerging. As in eastern Oregon, it is about one-third as abundant as *umbrosa occidentalis* and has apparently identical habits.

24. *MACROMIA MAGNIFICA* McLachlan.

This species occurs on Satus Creek, south of Alfalfa. It occurs during July and August.

25. *CORDULIA SHURTLEFFI* Scudder.

I took one female on Satus Creek, south of Alfalfa.

26. *SOMATOCHLORA SEMICIRCULARIS* (Selys).

I have not taken this in the territory described at the beginning of this list, but found it common at Bumping Lake, one of the head waters of the Yakima River.¹

27. *LIBELLULA FORENSIS* Hagen.

This is the most abundant *Libellula* about the ponds of the Yakima Valley. It occurs from June to August.

28. *LIBELLULA QUADRIMACULATA* Linnaeus.

The only place I have found this species is in a small pond east of Emerald station, not more than two dozen having been seen.

29. *LIBELLULA PULCHELLA* Drury.

This species was found occasionally about the sloughs in Parker Bottom near Donald.

30. *PLATHEMIS LYDIA* (Drury).

This was found occasionally about all the ponds from June to August.

31. *ERYTHEMIS SIMPLICICOLLIS* (Say).

This was found about all ponds from June to August.

¹ Kennedy, Clarence Hamilton. Notes on the Odonata, or Dragonflies, of Bumping Lake, Washington. Proc. U. S. Nat. Mus., vol. 46, No. 2017, pp. 111-126, September 30, 1913.

32. *SYMPETRUM CORRUPTUM* (Hagen).

This species was the first *Sympetrum* on the wing, appearing the first week in June and lasting till frost. It was never abundant, seldom more than a half dozen specimens being seen on any single day, but it is met with on all ponds and streams.

33. *SYMPETRUM COSTIFERUM* (Hagen).

This is the most abundant *Sympetrum* about the alkaline ponds. I have seen thousands of this species on a telephone wire for a stretch of a mile and all facing the same way.

34. *SYMPETRUM OBTRUSUM* (Hagen).

I have only two male specimens of the white-faced form of this species. These were taken on Satus Creek.

35. *SYMPETRUM OBTRUSUM* (Hagen) var. *DECISUM* (Hagen).

This is abundant about the ponds, but more abundant in the upper valley than about Sunnyside.

36. *SYMPETRUM PALLIPES* (Hagen).

This beautiful species is never abundant anywhere, but it is found sparingly about the alkaline ponds as well as along Satus Creek.

37. *SYMPETRUM MADIDUM* (Hagen).

This species is peculiar in that the males and females are seldom found associated. The females only were found on Satus Creek south of Alfalfa Station. On Logie Creek, an upper tributary of Satus, both males and females were found as teneral on June 15.

38. *SYMPETRUM SEMICINCTUM* (Say).

Common in the valley everywhere.

39. *SYMPETRUM VICINUM* (Hagen).

Found only on Satus Creek south of Alfalfa. Here it emerged during August.

40. *LEUCORRHINIA INTACTA* (Hagen).

One specimen was taken on a pond south of Sunnyside.